The Only Journal With a Paid Circulation in the Rock Products Industry

Rock Products

Vol. XXIV, No. 19 CHICAGO September 10, 1921

EDITORIAL DEPARTMENT—

Nathan C. Rockwood, Editor
Chas. A. Breskin, Associate Editor

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Charles H. Fuller, Eastern Manager,
101 West 41st Street, New York City

A. S. Barnett,
Western Representative

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ROCK PRODUCTS—

Geo. P. Miller, Manager
E. M. Gibson, Assistant Manager

Published every other Saturday by

TRADEPRESS PUBLISHING CORP.
542 South Dearborn Street, Chicago, Ill.

W. D. Callender, President.
N. C. Rockwood, Vice-President.
Geo. P. Miller, Treasurer.
C. O. Nelson, Secretary.

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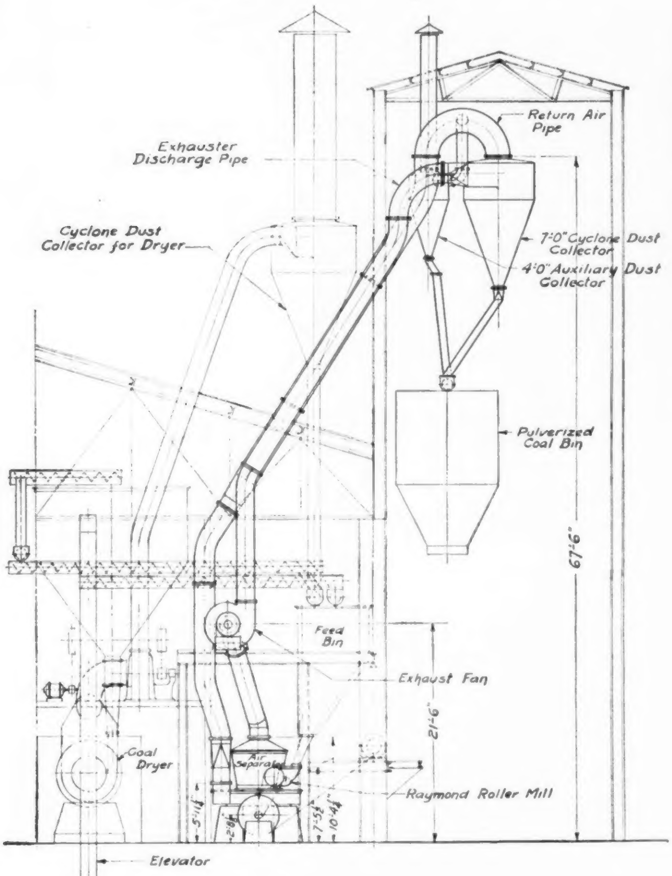

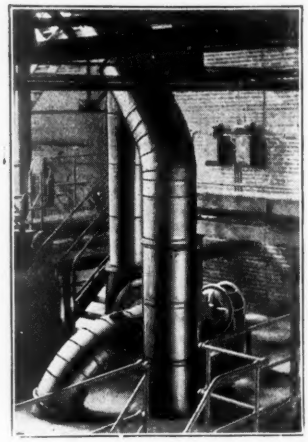

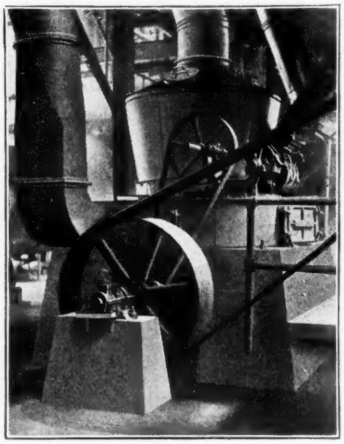

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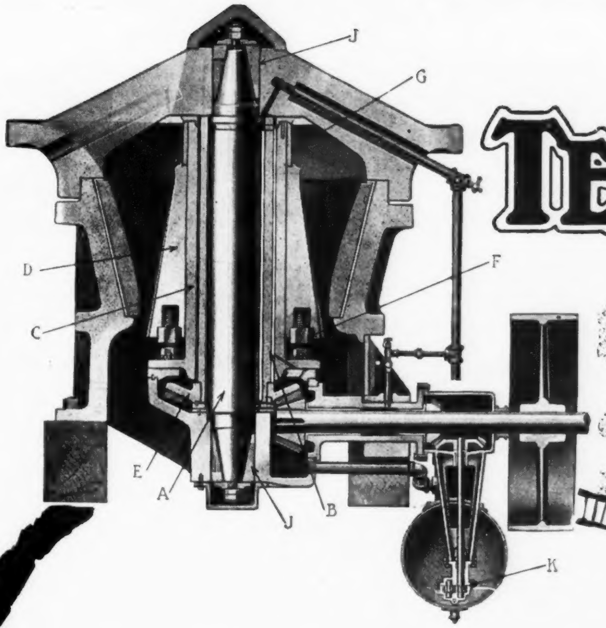

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Rock Products

Vol. XXIV — Chicago, September 10, 1921 — No. 19

Lime in the Chemical and Allied Industries

It Is Rightly Termed "The Queen of Bases"

By M. E. Holmes, Ph. D.

Manager of the Chemical Department, National Lime Association, Washington, D. C.

Dr. M. E. Holmes

LIME IS A CHEMICAL. Furthermore, it is one of the most important materials used in the chemical and allied industries. Although the birth of the lime industry was in its construction uses and although the development of this industry through the centuries of ancient times was in its construction and agricultural uses only, yet in recent years it has come to such an extensive use in our technical industries that it can safely be stated that, at the present time, the lime industry finds its most important outlet in the chemical and allied industries. It was the war which established a full realization of this situation.

The construction uses of lime remain the most important single outlet for the lime industry, and the merits of lime for this use justify a large expansion. Likewise, the agricultural use of lime is one of the more important single outlets and there is certainly a large tonnage of lime for use on the soil which will be developed as the years go by. It is very significant, however, that the combined tonnage of lime in the construction and agricultural uses in 1918 was but 40 per cent of the total. The remaining 60 per cent went into the chemical uses distributed among about 120 different industries. In 1919 the chemical uses of lime amounted to 52 per cent of the total and in 1920 to 53½ per cent of the total. In considering these figures, it is important to remember that they do not include certain very important items representing the production of lime by certain chemical manufacturers for their own use. The alkali manufacturers alone produce and use over one million tons of lime per year. When all the lime produced in this country is considered, the percentage going into the chemical industries is very much larger than the above stated 60 per cent.

The figure shown herewith gives the distribution of the chemical tonnage for 1918 as reported by the U. S. Geological Survey. Paper mills consumed the largest tonnage, followed closely by the refractory, metallurgical, alkali, carbide, sanitation and leather industries. Under the head of "unspecified chemical uses and miscellaneous," are included numerous uses, the tonnage for each of which is very small, but the combined tonnage is very important.

Many of these apparently insignificant uses may at any time develop into one of the larger and more important ones. The fact that their number is so large augurs well for the possibility of greatly increasing the chemical lime tonnage. The stability of the lime industry is largely due to the multiplicity of lime uses because when business in one of the chemical industries is dull there is demand in others.

Reasons for Prominent Place of Lime

A reason for the prominent place of lime in the chemical industries is not difficult to find. The lime industry in itself is a chemical one. The burning of limestone is an industrial application of a physical-chemical process as is also its hydration in making hydrated lime. The main reason is, however, that lime possesses the capacity of functioning in a remarkably large number of diverse chemical and engineering processes.

It has been said that sulphuric acid is the king of acids. In like manner it may be said that lime is the queen of bases. These materials are known as the king and queen of their class respectively because they may be used in producing all the other members of their class. Sulphuric acid is used in making hydrochloric acid from chlorides and nitric acid from nitrates. In similar manner, lime is used in making caustic soda from sodium carbonate and caustic potash from potassium carbonate.

The importance of this fact is apparent when it is remembered that chemical compounds can be divided into three classes, i.e., bases, acids, and salts. The salts are made from combinations of bases and acids. It is apparent, therefore, that from this point of view, lime and the other bases made from it together with sulphuric acid and other acids made from it are the fundamental materials in chemistry and the chemical and allied industries.

Not only is lime of such fundamental importance as a producer of other chemicals, but it is in the foremost ranks among chemical compounds in the number of important physical and chemical properties which it possesses. It is difficult to find a chemical substance which will function in so many different ways in the technical industries.

Lime as a Chemical Agent

Lime is a dehydrating agent. It will combine with the occluded water and the water

of constitution of certain chemical substances rendering them anhydrous. For this reason, lime finds use in the manufacture of alcohol, both ethyl and methyl, and in the petroleum refining industry for dehydrating crude petroleum and greases. It, therefore, commends itself to the attention of every manufacturer employing processes of dehydration.

Lime is a coagulating agent. A suspension of lime contains charged particles which will neutralize the charge of colloidal material flocculating it and clarifying the liquid by "settling out." It is due to this specific property of lime that it finds extensive application in the sugar industry. It is used for defecating raw sugar juices, a process which is accelerated by carbonating and sulphitating the lime in suspension. The carbonated lime in settling carries with it flocculated and absorbed colloidal matter producing a clear clarified juice.

The coagulating capacity of lime finds use for itself in the mining industry. Ore slimes are made to coagulate and settle rapidly by flocculation with lime. The efficiency of the process is thereby greatly increased through reducing the time of operation. The use of lime in the artificial ice industry also depends upon the coagulating capacity of lime. Water suitable for artificial ice must be clarified and purified and the most satisfactory process for this is the use of lime in combination with other reagents.

Lime also finds use as a flocculating agent in the rubber industry. The latex may be flocculated with lime and the clay used in making the compounding ingredients are flocculated with lime to render them suitable as a filler for the rubber. The use of lime in the sorghum industry also depends upon its coagulating capacity. The sorghum juice is clarified with lime in preparing it for the boiling operation. The coagulating action of lime is also employed in the disposal of sewage whereby the sewage is clarified by coagulating the colloidal matter with lime in combination with other chemical substances. Similarly water supplies may be deodorized and deferridized. Waste waters are also coagulated and disposed of with the use of lime. The coagulating action of lime is one of its most important properties and its uses by virtue of this property are very numerous.

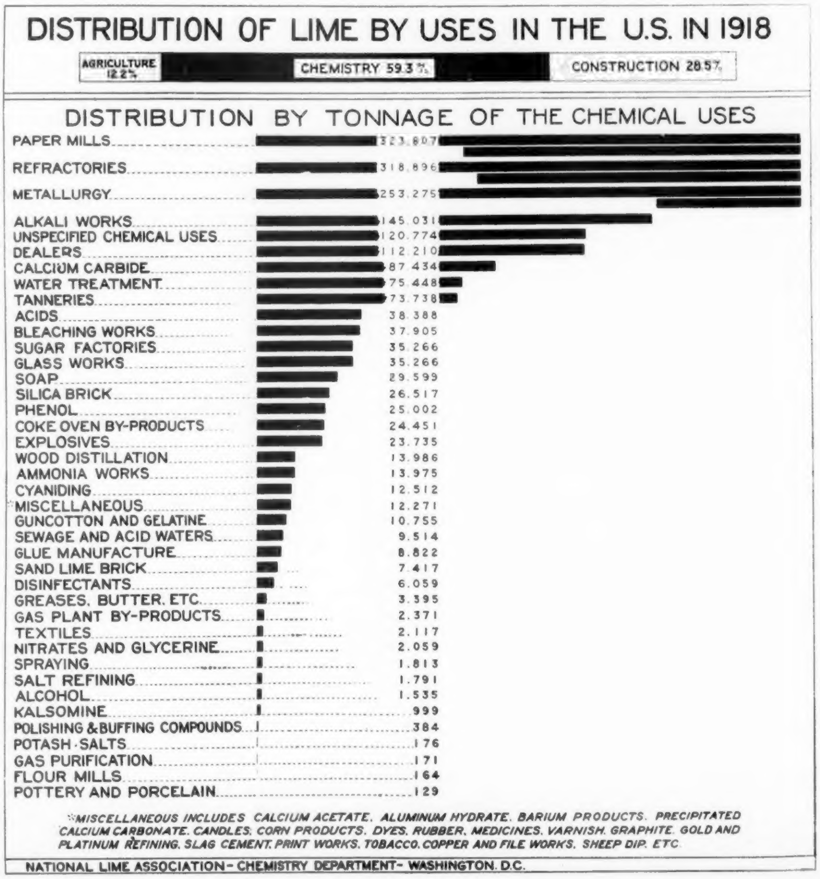
Lime functions as an absorbent for gases. Being a basic substance it will readily absorb practically all acid gases. This property of lime makes it useful in the electrolytic-alkali industry in which it is used to absorb and combine with chlorine in making bleaching powder, alkali hypochlorites and chlorates. It is the absorbing capacity of lime which makes it useful in the fixation of atmospheric nitrogen, where it is used to absorb nitrogen oxides in making nitric acid. Lime also finds use in the paper industry. As a result of its capacity for absorbing gases, lime will absorb sulphur dioxide forming bisulphites and sulphites which are used for making paper pulp. For the same reason lime is used in purifying illuminating gas in which process it absorbs sulphur dioxide, hydrogen sulphide and hydrocyanic acid, rendering the gas non-corrosive to boilers and metal fixtures. The absorption of carbon dioxide by lime is a process employed in the carbonation of sugar juices and in the manufacture of magnesia insulating material and in the manufacture of phenol. In the wood distillation industry the absorption of acetic acid vapor by lime produces acetate of lime. Acetic acid may then be made from the acetate by distillation with sulphuric acid.

Lime is a causticizing agent. As such it is used in reacting with alkali sulphates, carbonates and phosphates forming hydroxides. This property of lime makes it useful in the paper industry where it is used for making caustic soda for use in the soda and sulphate pulp process. Similarly it is used in making the bases for hypochlorites in the bleaching industry, and alkali salts in general in the inorganic chemical industry. The various hydroxides made by causticizing with lime can be combined with the many acids forming a long array of inorganic salts. The causticizing action of lime is employed in the soap industry. Soaps are alkali salts of inorganic acids made from hydroxides produced by causticizing with lime. The causticizing action of lime is employed in the textile industry also wherein cloth fibers are mercerized with alkalis produced by the caustic action of lime.

Lime is a hydrolizing agent. As such it is employed in the manufacture of hydrolized glue which is used in the prevulcanization treatment of rubber. By hydrolysis of aluminum nitride the compound is decomposed forming ammonia. This is a part of a process that may develop into an important means of fixing atmospheric nitrogen. The hydrolytic action of lime is also used in treating cellulose for the manufacture of material suitable for making a pulp cloth.

Lime is a saponifying agent. As such it is used in the treatment of fats, waxes and greases whereby organic compounds such as glycerine may be "split off" and the alkaline-earth salts of the fatty acids produced. By this process the animal products industries produce glycerine, glues, soaps, lubricating greases and paints and cleanses wool and unhairs hides. Lime is also used in saponifying oils and in making lubricating greases and tar products and for use in making roofing material and waterproofing compositions. Lime is also used to saponify organic salts and in making organic hydroxides in the dye and organic chemical industry.

Lime is a solvent. As such it is used in the treatment of hides whereby the ce-



menting material is disintegrated and removed. For this reason along with others it finds extensive use in the tanning industry. Lime will also dissolve casein and as such it is used largely in the cold water paint industry. Lime in fused slag will dissolve sulphur and phosphorus and thus it finds use in the metallurgical industry for purifying steel and other metals.

Lime is an oxidizing agent. As such it is used in the electro-thermic industry where it oxidizes carbon thereby reducing itself, forming calcium carbide. Similarly lime has been used in a simple laboratory way for making metallic calcium. Of much more importance, however, is the manufacture of calcium silicide whereby lime functions indirectly as an oxidizing agent.

Lime is a reducing agent. As such it is used in the manufacture of calcium peroxide by reduction of hydrogen peroxide or other strong oxidizing agents. This is one of the newer uses of lime which may have important possibilities.

Lime is a lubricating agent. As such it is used in the high temperature lubrication of dies in the drawing of steel wire. Its fineness and refractoriness makes it especially suitable for this use.

Lime is a fluxing agent. As such it is used extensively in the basic open hearth process for refining steel and for the manufacture of pottery, and porcelain in the ceramic industry.

Lime is a catalyzing agent. It functions as such in the peroxidation of alkalis forming such products as sodium peroxide. It also catalyzes the formation of calcium cyanamide in the action of calcium carbide on nitrogen. Lime also catalyzes the vulcanization of rubber, and the hydrogenation of nitrogen in the Haber process of fixing atmospheric nitrogen. In the fusion of chromite with alkalis, lime functions as a catalyst in the preparation of alkali dichromates. The esterification of glycerine and the manufacture of chlorine in the Weldon chlorine process also involves the catalytic action of lime.

Lime is an ionizing medium, whereby it finds application in the production of metals by electrolysis of fused metals and in the electrical method of sewage disposal.

Lime is a refractory. Its melting point and sintering point are exceeded by only a very few substances. It finds use, therefore, as such in the manufacture of dead burned dolomite, silica brick and the like as refractory lining for furnaces and as insulating material for steam pipes.

Lime is a precipitating agent. As such it finds extensive use in the preparation of many inorganic and organic salts in the winning of metals from ores and the preparation of rare earth oxides from monozite sand, in the preparation of absorption media such as iron hydroxide in the purification of water and in the preparation of colloidal pigments such as satin white.

Lime functions in various capacities in distillation. Lime is used in the distillation of coal, and oil shale to produce ammonia and ferro-cyanides and to enrich and purify the coal gas. In the wood distillation industry lime is used in the distillation of pyroligneous acid in making aluminum acetate, acetic acid, acetone and methyl alcohol. The distillation of gas works liquors with lime produces many thousand tons of ammonia yearly.

It is futile to attempt to cover in one brief article all of the functions of lime as represented by its manifold uses. It would not be permissible, however, in any article on this subject to omit the use of lime as a base or neutralizing agent. As mentioned above, lime is the queen of bases and by virtue of its composition (CaO and $Ca(OH)_2$) belongs to that class of chemical substances called hydroxides which will neutralize acids. Lime is used for neutralizing resinous acids for use in making varnish and enamels in the paint industry, and for use in making stabilizing media for liquid fuels. Ores are neutralized with lime in ore flotation and in the cyanide process in the mining industry.

Organic acids are neutralized with lime in making lubricants, oil cloth and candles. Tar acids are neutralized with lime in making roofing material, bituminous paint, sulphonate detergents and lubricants in the hydrocarbon industry. The citrate industry employs the use of lime for neutralizing and recovering citric acid. Arsenic acid is neutralized with lime in making calcium arsenate in the insecticide industry. The manufacture of many mineral products involves the use of an excess of acids which is neutralized with lime. In the dye industry excess acids must be neutralized in the manufacture of phenol, sulphonated napthalene and anthracene. In the explosive industry excess acid is neutralized with lime in the manufacture of nitroglycerine. In making saccharified cellulose such as sawdust cattle food, excess acid used in hydrating the woody material is neutralized with lime. In like manner the acids used in pickling steel are neutralized with lime and the residual acids in Keene's cement and dried leather may be rectified with the use of lime.

Conclusions

Enough has been stated to show that lime possesses in a remarkable degree a great diversity of properties and is capable of functioning in an unusually large number of ways. It is, therefore, entitled to a large tonnage in the chemical and allied industries. The question may be asked, why this tonnage is not ten or fifteen million instead of two or three million. The most plausible answer would be that the lime manufacturers have in times past neglected the chemical uses of lime. The future expansion of the chemical tonnage of lime will depend primarily upon the technical activities of the National Lime Association. The lime manufacturers are to be congratulated upon their far-seeing plans in this important field by establishing at Washington a central research laboratory and a technical staff who will devote their entire time to serving the user of lime. This work is to be supplemented by co-operative research work under fellowships and other arrangements at universities, government and industrial laboratories. The association is therefore in a position to render scientific and technical service to the industries in their use of lime. That service is offered with the belief that the cheapness of lime and its broad range of usefulness commends its use to all manufacturers as a possible source of profit.

Lime Used in Treating Wastes from Water Gas Plant

WATER GAS WASTES at Flint, Mich., have been treated experimentally with 1,500 lb. of lime per million gallons of waste as a coagulant. A satisfactory effluent was obtained from 2 hours' sedimentation and filtration through a coke filter. The rate of filtration was 8 to 10 m.g.d. per acre through 24 in. of coke over which was placed 6 in. of coke breeze. The turbidity was reduced 95 per cent, color 90 per cent, oxygen consuming value 95 per cent and total solids to 100 p.p.m. There was left no visible trace of oil and only a slight taste and odor.

The normal waste contained 200 to 500 p.p.m. of turbidity, 500 to 1,500 total solids, 1,000 p.p.m. oxygen demand. Laxity in operation of the gas plant may produce an inky black waste having an oxygen consuming value of 1,800 p.p.m. and total solids of 11,000 p.p.m. Baffling was considered undesirable as the oil comes to the top best under the most quiescent sedimentation possible. After 2 to 3 hours plain sedimentation and filtering at the rate of 1½ m.g.d. per acre the coke filter became clogged in a few days with an oily, tarry material which penetrated to the bottom of the coke filter. The turbidity reduction was 75 per cent, the color none, oxygen consumed 40 per cent, and total solids 50 per cent. The effluent had a gassy odor and taste and retained some light oils. The experiments were carried out by J. R. Pollock, sanitary engineer, city engineering department, Flint, and reported by him in a paper presented recently to the Michigan section of the American Public Health Association.—*Engineering News Record.*

[An article on the use of lime for the chemical precipitation of trade wastes appears elsewhere in this issue.—Editors.]

Needed! Complete and Reliable Analyses of Limestones

Progress in the Industry Requires Greater Knowledge of the Impurities Found in Limestones—Their Kind, Form and Effect

(Published by permission of the Director of the U. S. Geological Survey)

By G. F. Loughlin
Geologist in Charge, U. S. Geological Survey, Washington, D. C.

THE VALUE of chemical analyses of limestones is recognized by the writer from two viewpoints: that of purely scientific research, and that of commercial application. Studies of sedimentation and of the origin (petrology) and alteration of limestones have progressed to a point where accurate knowledge of the major and minor constituents of limestones and dolomites is indispensable, and developments in chemical manufacturing processes have reached a similar status; but most published analyses are too incomplete to afford satisfactory interpretations and may readily lead to erroneous conclusions. Realization of this fact has been brought about in purely scientific work during study of the relations between dolomites and limestones and in the comparison of analyses with results obtained by microscopic study, and frequently in commercial work when the writer has been called upon to supply information regarding limestones that will satisfy unusually exacting requirements. It is true that for several uses of limestone little is required beyond a determination of lime and magnesia, but the number of these uses has been gradually growing less as knowledge of the chemical processes involved has advanced.

A recent example of the need for more complete analyses is a paper by W. E. Byron Baker, entitled, "Limestone analysis and evolution for bisulphite liquor manufacture,"[1] which states that the quality of the pulp is influenced by the extent of impurities in the stone and outlines methods for the determination of insoluble carbonaceous matter, silica, insoluble inorganic matter, iron oxides, alumina, alkalis, carbon dioxide, sulphur trioxide, sulphur as sulphide, hygroscopic moisture, and combined water. He also states that it is sometimes desirable to know the mineralogical constitution of the stone.

With this rather long list of determinations urged for a single use, the need of relatively complete analyses of limestones to be sold for several uses is not surprising. The producer of limestone or lime, who wishes to broaden his market must therefore be ready with the chemical data that he will sooner or later be called upon to furnish. The pure research problems of today have their practical application tomorrow, and more complete analyses, even if made primarily for pure research are only anticipating the future needs of industry.

Chemical analyses alone, however, even if complete, may not tell the whole story, as impurities, as well as a part of the lime and magnesia may be present in one or more minerals whose chemical and physical properties differ. These minerals may be identified by use of the petrographic microscope, either in thin sections of the limestone itself or in the insoluble residue. As many of these minerals are so minute as to be overlooked in the presence of brightly polarizing calcite and dolomite, examination of the insoluble residue is especially to be recommended. If the limestone is leached in very dilute hydrochloric (or better acetic) acid it may be possible to detect the more soluble silicates or other impurities such as ferric oxides in the residue. Preliminary microscopic examination will call attention to impurities present in sufficient quantity to require exact chemical determination and may also save the labor of searching for constituents with only negative results. Some impurities are of such serious importance even in minute quantities that a quantitative chemical determination of them should be required anyway, certainly until co-ordination of microscopic and chemical analyses has reached the point that limits of the microscope in detecting minute quantities of minerals has been demonstrated.

Character of Sample

Perhaps the most serious criticism of published chemical analyses is that very few are accompanied by a statement describing how the sample was taken, and whether it represents an average of an entire quarry, or only a certain bed, or only a hand specimen. All three kinds of samples are of value for one purpose or another, and some quarries are known which have been found to be so uniform in chemical composition that a single hand specimen may be a fair representative of the whole quarry, but as a general rule anyone using an analysis should know just what it represents.

It goes without saying that portland cement companies are obliged to keep complete records of their samples, also that careful producers of limestone and lime keep reliable records of the composition and variation of their stone; but to the engineer or other investigator searching for limestone of a certain grade, this essential information can now be obtained only by writing to the relatively few companies who have it available, or by thoroughly sampling a deposit that may have been thoroughly sampled one or more times before but whose samples and corresponding analyses have not been preserved. It is therefore urged that all chemical analyses be accompanied by brief statements of what the corresponding samples represent and the manner in which they were taken.

Constituents to Be Determined

Of the published analyses that have been assembled by the United States Geological Survey from many sources very few show the presence or absence of enough constituents to permit a positive recommendation of a stone or burned lime for more than a few uses. Many show only lime (CaO), magnesia (MgO), and "insoluble" and may be accompanied by calculated "equivalent" carbonates. These calculated equivalents may or may not be reliable, as the possible presence of ferrous carbonate is ignored, but the concealed contents of the "insoluble" is of more concern.

Insoluble—"Insoluble" has frequently been regarded in tabulated analyses as a synonym for silica, and indeed some form of silica is usually the most abundant constituent of it. Microscopic study of insoluble residues, however, shows that limestones and dolomites may contain, besides varying quantities of quartz, chert or flint, considerable quantities of feldspars, micas, clays, calcium and magnesium silicates, limonite, hematite, pyrite, fluorspar, and occasionally other minerals that are soluble even in rather dilute hydrochloric acid though not so readily as the carbonates are. Analyses in which

[1]Brief abstract in Chem. and Met. Engineering, April 28, 1920, p. 781.

the constituents of these minerals, at least the more abundant of them, are not shown are next to useless as an aid in answering inquiries for limestone or dolomite with a certain minimum percentage of some impurity, especially iron.

Silica, alumina, and ferric oxide—As silica and alumina have different properties and are of different degrees of importance in certain chemical manufacturing processes, their separation is very desirable and is necessary in the exact determination of iron oxides. It is therefore recommended that, while total insoluble should be recorded as of a certain practical value, silica, alumina, and ferric oxide should also be recorded separately. If this were done many of the writer's causes for complaint would disappear.

Ferrous oxide—Ferrous oxide is more commonly present than may be supposed, especially in dolomitic rocks. Qualitative chemical study by Steidtmann,[1] the writer, and doubtless others, has shown that this is present for the most part as ferrous carbonate, evidently isomorphous with calcium and magnesium carbonates in the mineral dolomite. Limestone with very little "insoluble," and that free from ferric oxide, may burn dark or pink because of ferrous carbonate present; also white dolomitic marbles, and a few high calcium marbles, apparently free from iron compounds, contain sufficient ferrous carbonate to prevent their use in the manufacture of high grade glass and certain other products. A definite determination of ferrous iron, especially in dolomitic limestones, is therefore strongly recommended.

Lime, magnesia, and carbon dioxide—Lime and magnesia in some limestones are partly present in silicates, and partial analyses in which only total lime and magnesia are determined and then calculated as carbonates are misleading. The writer recalls an analysis of this kind from which calcium carbonate was calculated to be 85 per cent but when the insoluble was added to this the analysis totaled 107 per cent. The apparent excess was due to the presence of considerable lime in the minerals epidote, tremolite, and diopside. Without determination of carbon dioxide, such partial analyses are of little value. Some of the silicates containing lime or magnesia are readily soluble in acids as used in the laboratory, but are practically insoluble in the weak acids of the soil and are not decomposed during burning so as to yield quick lime. The lime and magnesia as well as the ferrous iron, in carbonates should be definitely determined.

Alkalies—Inquiries regarding the presence of alkalies in limestones have commanded particular attention since sources of domestic potash have been sought, particularly potash as a by-product from portland cement plants and blast furnaces. As the potash content in raw cement mixtures is only a fraction of one per cent, small quantities of potash in one limestone may give it preference over another. Larger quantities of potash, known to be present in a few limestones, may increase its value for agricultural use, as potash minerals so far as shown by the microscope commonly occur in very fine grains. The microscope has shown that the insoluble residues of many limestones and dolomites contain a surprising proportion of feldspars. In the majority of the residues studied by the writer the plagioclase or soda lime varieties predominate, but orthoclase or microcline, the potash varieties predominate in some. Some of the feldspars are of detrital origin deposited as sand grains when the limestone was forming; others have grown as secondary crystals; still others are a combination of detrital grains surrounded by secondary accretions. Besides feldspar, microscopic white micas, muscovite or sericite, and less commonly brown and black micas (phlogopite and biotite) are present in limestone, adding to its potash content.

It is not intended to obscure the fact that most limestones now used contain so little "insoluble" that the percentage of potash is of no commercial interest, but the mode of occurrence of potash minerals in limestone and dolomite suggests that among those containing considerable insoluble certain ones may be found with sufficient potash content to render them of particular interest. An extreme example is a dolomite in Alberta, described by Daly,[1] which contains 5.77 per cent of potash (K_2O), equivalent to 34.5 per cent orthoclase. Daly also cites other limestones and dolomites containing conspicuous amounts of feldspar, and suggests that special search will prove them to be more numerous than heretofore suspected. The writer has received oral information of certain limestones in the West that contain more than 2 per cent of potash in silicates. The presence of potash minerals in limestones is at present of more purely scientific than commercial interest, but a little attention to this question by others than portland cement companies who produce potash will increase our knowledge concerning it.

Minor constituents. Other minor constituents, shown in analysis No. 1 and No. 2 in the following table, are of little or no consequence to some users of limestone and lime, but of considerable importance to others. Each user will doubtless call for a determination of the constituents in which he is especially interested, but the range of usefulness of any limestone can be learned only by determination of many if not all of them. As the writer is called upon from time to time to specify limestones within a limited area that possess certain chemical properties, analyses showing these minor constituents probably will appeal to him more than to manufacturers of certain commodities, and a call for such analyses must appeal to the broad consideration of science and industry in general rather than to a restricted view based on private needs.

Composite Analyses of Limestones.[1]

H. N. Stokes, Analyst

	1	2
SiO_2	5.19	14.09
TiO_2	.06	.08
Al_2O_3	.81	1.75
Fe_2O_3	.54	.77
FeO	undet.	undet.
MnO	.05	.03
CaO	42.61	40.60
SrO	none	none
BaO	none	none
MgO	7.90	4.49
K_2O	.33	.58
Na_2O	.05	.62
Li_2O	trace	trace
H_2O	.21	.30
H_2O and organic	.56	.88
P_2O_5	.04	.42
CO_2	41.58	35.58
S	.09	.07
SO_3	.05	.07
Cl	.02	.01
F	undet.	undet.
	100.09	100.34

The conspicuous feature of the two composite analyses here quoted is the recorded absence of barium and strontium, in spite of the fact that much of the barite of commerce is produced from residual soils left by the weathering of limestone, and that strontium is known to occur in a few limestones. As a "trace" in chemical analyses implies a quantity between 0.01 and 0.001 per cent, these oxides could be present to the extent of a few tenths of a per cent in a few analyses and be less than 0.001 per cent in the composite analyses.

No questions of commercial interest, to the writer's knowledge, have arisen regarding barium or its compounds in limestone, but strontium has been suggested by Emley[2] as a cause of plasticity or "spreadability" in certain magnesian hydrated limes. Only high calcium and low magnesium limestones appear to be represented in the two composite analyses. The question of plasticity is one of sufficient importance to warrant enough chemical determinations of strontia in limestones which yield hydrates of different degrees of plasticity to demonstrate the validity of this hypothesis.

Manganese and titanium are two elements which chemical analyses have

[1]Steidtmann, E. Origin of dolomite as disclosed by stains and other methods. Bull. Geol. Soc. of America, vol. 28, pp. 153-154, 1917.

[1]Daly, R. A. Low-temperature formation of alkaline feldspars in limestone. Proceedings Washington Acad. Sci., vol. 3, pp. 659-665, Nov., 1917.

[1]From U. S. Geological Survey's Chemical Laboratory record book, lot. No. 1632, p. 319. No. 1 composite analysis of 345 limestones. No. 2 composite analysis of 498 limestones used for building purposes. These analyses are published in Bulls. Nos. 491, 616 and 695 (Data of Geochemistry, editions 2, 3 and 4, by F. W. Clarke), but SrO and BaO are omitted.

[2]Emley, W. E. "What is the cause of plasticity?" Rock Products, vol. 20, Dec. 19, pp. 39-40, 1917.

shown to be widely distributed in small quantities in rocks of various kinds, but neither have come to the writer's attention in connection with the utilization of limestones. Manganese may be of interest to glass manufacturers as a neutralizer of the green color due to iron. Recent studies of manganese ores by members of the United States Geological Survey have brought to attention certain carbonate ores whose mode of occurrence suggests an origin intimately connected with the deposition and alteration of limestone, and determination of manganese in limestones and dolomites would be helpful to this geologic problem. Both manganese and titanium in limestone fluxes should be of some interest to manufacturers of steel, and definite records of their presence should perhaps be of equal interest.

Lithia, whose presence in exceedingly minute traces is readily detected, is of no present commercial interest to limestone producers, and its determination for purely scientific record is not to be urged unless it can be made at little or no additional expense.

Water, whether hygroscopic or expelled at 110° C., is of no practical importance in limestone analyses unless in rare exceptions where its presence in considerable quantity may serve as a warning against too rapid heating with resulting decrepitation in the kiln. Its presence together with that of certain other constituents could suggest the presence of certain minerals which the microscope could prove in less time. Its exact determination, however, may be necessary in connection with the exact determination of carbon dioxide, organic matter, and sulphur compounds.

Organic matter may exist in more than one state. Some, which gives a bluish gray color to some limestones, is removed from the ledge by oxidizing waters circulating above ground water level, and is presumably easily driven off by ignition; some which resists this process and gives a brown color to the oxidized rock is ignited with difficulty. Organic matter in limestones used in the manufacture of bisulphite liquor is an objectionable impurity, and its presence must also be accounted for if carbon dioxide is to be determined accurately. It is, of course, of general geologic interest and may be of special interest as practical questions regarding the genesis and distribution of petroleum.

Phosphorus is present in some of the shells that contribute to the formation of limestones today,[1] but very few analyses of limetsones show that its presence or absence has been determined. In some limestones very little if any phosphorus is present, whereas in other limestone formations phosphorus has been concentrated in so great quantity along certain beds that they are termed phosphate rock and are mined for their content of calcium phosphate. The phosphate content of limestones may vary between these two extremes and may be irregularly distributed. The tendency to vary is illustrated by the two composite analyses, which also indicate that the phosphorus content of many limestones is too high to permit their use as flux in the manufacture of iron and steel. Determination of phosphorus is absolutely necessary in selecting limestone flux, yet its presence or absence is indicated in surprisingly few analyses, and very little appears to be definitely known about the distribution of phosphorus in limestones.

[1]Clarke, F. W., and Wheeler, W. C. U. S. Geol. Surv. Prof. Paper 90, p. 33, 1915; Prof. Paper 102, 56 pp., 1917.

Sulphur in the form of pyrite is widely distributed in limestone, for the most part in very small quantities of minute crystals, but in some places in relatively abundant large grains readily detected without a microscope. Pyrite during the burning of limestone is converted into black specks of magnetic iron oxide or red spots non-magnetic oxide, either of which in sufficient quantity will decrease the value of the lime. Burning a sample to determine this character is more practical than a chemical determination of sulphur, but comparative analyses of satisfactory and discarded stone will indicate the maximum percentage of sulphur that can be tolerated. Sulphur in sulphates, according to the composite analyses, may be present in small quantity, presumably in the form of gypsum or anhydrite, as strontium and barium are absent; but strontium sulphate is present in a few limestones. Small quantities of these minerals can easily be overlooked. Total sulphur, like phosphorus, must be determined in limestone intended for flux.

The minute quantities of **chlorine** shown in the composite analyses may represent salts from sea water trapped in the limestones. It is doubtful whether such small quantities are of any commercial interest, and there is no occasion for urging its determination in analyses.

Fluorine, undetermined in the two analyses, is also of little general importance, although its occasional presence to the extent of a few tenths or even hundredths of 1 per cent may bar the stone from certain uses. The writer, while examining several limestones from North Carolina, noted one in which fluorspar (calcium fluoride) was a conspicuous "insoluble" mineral.

Analyses of Certain Dolomites from Massachusetts

As several samples of dolomite from western New England were recently submitted by T. Nelson Dale[1] of the United States Geological Survey for chemical analysis, the opportunity was taken to make rather complete analyses of five of them with the following results:

Fluorides, soluble sulphates, and chlorides were not found.

Soluble phosphate was not present in amount greater than 0.06 per cent in any of the samples, and was probably less than 0.03 per cent where not determined.

The analysis of the insoluble material is fairly exact, considering the difficulty of separating a large mass of soluble chlorides from it. The figures for H_2O and SiO_2 are subject to greatest error. Water was found hyignition of the dried insoluble. Silica was then volatilized directly as the tetrafluoride and the soluble alkalies leached out of the residue.

Samples: Typical hand specimens from ledges of uniform character in the dolomite member of the Stockbridge limestone collected by T. Nelson Dale from undeveloped properties, except No. 4.

No. 1. West Stockbridge, Mass. J. G. Fairchild, analyst.

No. 2. West Stockbridge, Mass. J. G. Fairchild, analyst.

No. 3. West Stockbridge, Mass. J. G. Fairchild, analyst.

No. 4. Hutchison Quarry, Lenox, Mass., J. G. Fairchild, analyst.

No. 5. Renfew, Mass. J. G. Fairchild, analyst.

The samples, although from ledges of uniform character, are open to the objection that they are not strict averages. As they all represent one formation, however, they have a certain aggregate as well as individual value. They show considerable variation in chemical composition of the formation as a whole and suggest the necessity of obtaining strictly average samples if the run of quarry stone is to meet exacting chemical requirements. Representation of the

[1]These dolomites are described in a forthcoming bulletin of the U. S. Geol. Survey entitled "Lime-producing belt of Mass. and Conn."

	1	2	3	4	5
INSOLUBLE IN HYDROCHLORIC ACID					
SiO_2	1.83	11.03	1.58	4.17	0.68
Al_2O_3	.60	2.23	.42	1.36	.07
Fe_2O_3	trace	not det'd	not det'd	.15	not det'd
TiO_2	trace	trace	trace	.05	none
CaO	not found	not found	not found	present	not found
MgO	not found	.12	.14	.46	not found
K_2O	.30	.64	.17	.69	trace
Na_2O	.08	not found	not found	trace	.05
H_2O	not det'd	.16	not det'd	.15	not det'd
SOLUBLE IN HYDROCHLORIC ACID					
SiO_2	not det'd	not det'd	not det'd	0.85	not det'd
Al_2O_3	none	none	.06	.13	none
Fe_2O_3	trace	trace	trace	.33	.05
FeO	0.31	.21	.18	.80	.20
CaO	39.53	27.08	30.52	30.02	31.30
MgO	12.99	18.06	20.85	17.74	20.75
CO_2	44.48	40.38	46.50	42.66	46.86
P_2O_5	not det'd	not det'd	.03	.06	not det'd
	100.12	99.91	100.45	99.62	99.96

different constituents in two groups is not necessary, but is of assistance to one especially interested in the chemistry of limestones. Although silicia and alumina are ordinarily assumed to be represented by "insoluble," small quantities of them, mostly too small to deserve accurate determination may also be present in the "soluble" portion.

Microscopic examination of the insoluble residues gave the following results:

No. 1 is nearly half quartz. The remainder mainly of potash feldspar (microcline or orthoclase) and white mica (muscovite) in approximate ratio of 3 to 1. A few grains of magnetite were also noted. The relative quantities of these minerals check satisfactorily with the insoluble constituents in the analysis.

No. 2 does not check so satisfactorily. As seen under the microscope, it is about two-thirds quartz, with considerable potash feldspar, a little magnesium mica (phlogopite), and very little magnetite. Calculation of the quantities of these minerals from the analysis would give about 0.4 per cent mica, more than 2 per cent feldspar, and about 9 per cent quartz, with an unaccounted excess of 1.5 per cent alumina and nearly all the water.

No. 3 consists about half of magnesium mica and half of quartz with a little potash feldspar, the microscopic examination agreeing closely with the insoluble part of the chemical analysis. The small quantity of soluble alumina recorded in the analysis is presumably a corresponding slight corrosion of the mica by hydrochloric acid.

No. 4 consists of the black iron-magnesium mica, biotite (about 4 per cent), potash feldspar (1¼ per cent) and quartz 1½ per cent, the microscopic examination checking closely with the insoluble of the analysis, which totals 7 per cent. The magnesia, water and most of the ferric oxide are accounted for. A few grains of soda-lime feldspar, tremolite (calcium magnesium silicate), garnet (calcium-aluminum-iron silicate) and limonite (hydrous ferric oxide) are also present, but in too small quantity to affect calculations from the analysis, other than to account for the presence of insoluble lime. The magnesia, water, and most of the ferric oxide are accounted for by the biotite, as is most of the alumina and potash. The titanium dioxide either belongs to the biotite or to minute crystals of rutile inclosed in the biotite. The soluble alumina and part of the soluble ferric and ferrous oxides and silica are attributed to partial decomposition of biotite by hydrochloric acid, and imply that a small quantity of potash (about .04 per cent) was dissolved with them. Although the quantity of soluble silica is small, it would be sufficient in some analyses to bring total silica above the maximum limit tolerated for certain uses.

A comment on the strength of acid used is pertinent here. If a more dilute, cold acid had been used in analysis No. 4, less biotite and limonite would have been dissolved at the expense of more time. If a detailed mineralogic examination is desired, the coarsely ground rock should be leached first in very dilute hydrochloric or dilute acetic acid, which dissolves the free calcite and practically nothing else. Treatment of the residue with somewhat stronger cold hydrochloric acid will dissolve the dolomite grains, but its action on iron oxide and most silicates will be too slow to affect the result appreciably. If quicker results are desired, stronger hot acid must be used, and the analysis may be interpreted as in the preceding paragraph.

No. 5 is about half quartz and about half soda feldspar (albite), the microscopic and chemical analyses checking closely.

The insignificance of soda in these five analyses is contrary to the writer's observations in North Carolina, where the soda-lime feldspar is more conspicuous than potash feldspar in dolomites and limestones. The quantity of potash in No. 4 is sufficient from the agricultural standpoint to offset the rather high percentage of silica and alumina.

Phosphorus pentoxide, though definitely determined in only two analyses, is definitely shown to be present in only negligible quantity in the others. Soluble sulphates were also looked for but not found, and there is no suggestion of pyrite. Neither could fluorides and chlorides be detected. The adaptability of these samples for any chemical use can therefore be definitely determined.

Recalculation of the carbonates reveals in all the analyses a relative deficiency of carbon dioxide—small, but nevertheless beyond the limits of error (about 0.5 per cent). These deficiencies of carbon dioxide are as follows:

Analyses	1	2	3	4	5
Deficiency of CO_2 (pct.)	0.97	0.92	0.48	0.92	0.70

The ratio of lime magnesia and ferrous oxide in dolomite is not definitely known. If, however, it is assumed that the molecular ratio of magnesia plus ferrous oxide equals that of lime, analyses No. 1 may be recalculated as follows:

$$\text{Dolomite} \left\{ \begin{array}{lr} CaCO_3 & 32.65 \\ MgCO_3 & 27.15 \\ FeCO_3 & .50 \end{array} \right\} 60.30$$

Calcite	35.89
Excess calcium oxide	1.13
Total insoluble	2.81
	100.13

The source of the excess calcium oxide may be one or more silicates which are decomposed by hydrochloric acid, leaving a residue of insoluble silica. A search for such silicates should be made either in thin section or in the residue left after leaching in extremely dilute hydrochloric acid or in acetic acid.

Conclusion

The practical importance of such complete analyses is, of course, determined by the ratio of added cost to added value received. The added value is a definite knowledge of the adaptability of the stone for all possible uses, present and future. Chemical analyses alone will not answer all questions of the behavior of a stone during or after burning, as some physical properties may be independent of chemical composition. Physical tests supplemented by microscopic study are necessary to furnish the additional information. There is no doubt, however, that our general knowledge of limestones and their usefulness will be strengthened by greater completeness of analyses than the majority of analysts have made.

It is suggested that all analyses show at least the following constituents separately:

SiO_2	total.	(Soluble and insoluble SiO_2 may be distinguished if rare occasions warrant.)
Al_2O_3	total.	(Do)
Fe_2O_3	total.	
FeO	total.	
MgO	total.	
CaO	total.	
CO_2	total.	(Actual determination should be made when total insoluble exceeds 1.5 or 2 percent, or where the exact amount of quickly available calcium and magnesium oxides must be known.
H_2O	below 110°C. and above 110°C.)	

The above named constituents, except CO_2 and H_2O, are of importance in too many different chemical manufacturing processes to be omitted. The CO_2 and H_2O are necessary to insure proper interpretation of these essential constituents. The other constituents cited in this paper are of varying importance and their determination cannot be so strongly urged. When once determined and found to be in only insignificant quantity they need not be looked for in future analyses from the same quarry unless changes in the character of the stone justify it.

If "insoluble," total or itemized, is recorded the kind and strength of acid used should be specified.

The kind of sample taken should be specified and a part of it should be preserved for reference, and, if occasion demands, for microscopic study of the whole or the insoluble part.

The annual statistical inquiry sent to producers by the United States Geological Survey contains a request for copies of chemical analyses and other tests. If any producers or consumers who have or shall soon have more complete analyses would submit copies of them, these can serve as the bases for a general study of limestone and dolomite, or of carbonate rocks in general to extend our scientific and economic knowledge of limestones.

After completing this paper, the writer has been reminded of a paper by Hillebrand entitled "A plea for greater completeness in chemical rock analyses."[1]

[1]Hillebrand, W. F., Jour. Amer. Chem. Society, vol. 16, pp. 90-93, 1894.

This paper emphasized particularly analyses of igneous rocks, and advance not only in the knowledge of igneous rocks and related geologic problems of purely scientific and economic character but in methods of analysis since that time has been great. More complete analyses of limestones may also develop more refinement in certain analytical methods and besides throwing light on the different questions raised in the foregoing pages may reveal that certain unsuspected impurities exert a marked influence on chemical or physical properties of both limestone and the lime made from it.

Lime in the Textile Industry

Opportunities for Greatly Extending Its Use

By Elton Richmond Darling
Professor of Chemistry, James Millikin University, Decatur, Ill.

TRADITION has been responsible in many cases, for our lack in adopting a new process or method. Why we adhere so closely to old standards, and are not willing to accept the new, is a difficult question to answer. It is true, nevertheless, that the closer we adjust ourselves to the new workings of economical principles, as they apply to our various industries, the better will be our position to meet conditions brought on by foreign competition.

Lime is a natural product in this country, and its use should be fostered, instead of replacing it with a product of greater cost. Waste can be stated in various terms, one of which is the lack of use of products of abundance, through the use of other products more expensive. To the writer's mind, this is the worst kind of waste, and unless we can make full use of this product, we are in an economic sense wasting it.

Most every industry has a use for lime, or some product which they are now using, can be replaced by lime. As the writer finds it, this is especially true, today, of the textile industry. Of all the industries using alkalies, the textile industry holds an important place, and hundreds of tons of caustic soda and soda ash are yearly consumed in clearing textiles for the finishing processes.

Lime Originally Used

In 1815 lime was used for the same purpose that the stronger alkalies are now employed. When these stronger alkalies were placed upon the market, they were tried, for no reason, other than they were stronger than lime. In later years, attempts were again made to return to lime, the reasons being that it was not only satisfactory but cheaper. New difficulties then arose, the most pronounced being that the iron in the lime stained the goods. This was the situation in England, when the process was introduced in the United States, and that taint has followed it, and for years this has been the main reason why lime has not become generally used. The truth of the statement, regarding these iron stains, was never investigated until recently, when the writer showed that the average grade of American lime does not contain enough iron when used in the kier to affect the cloth in any way.

Lime used in the kier boil for the clearing of cotton cloth works very satisfactorily. The operation, as carried out, is to remove the fats, waxes, and pectin bodies. Lime fulfills this purpose with less drastic action on the cloth than when the stronger alkalies are used, and in fact, the lime has been found to act upon the pectin bodies in the cloth and remove them more efficiently than the stronger alkalies.

The Lime Boil

In carrying out the lime boil, the lime is first slaked and then made into a milk of lime solution of such strength, that after the goods have been passed through it and squeezed, they will contain between 1.5% and 2% of calcium oxide. The limed goods are then run into a kier and boiled for 12 hours, washed and then continued in process. This is what is known as a half bleach boil, and is satisfactory when the goods are going to be dyed with dark shades. For a full bleach, the goods after washing are run back into the kier and boiled for eight hours with a solution of soda ash containing 1.5% of the chemical, based upon the weight of the goods. The object of this is to remove the lime soaps.

Lime in Dyeing

In certain textile plants in this country an imported grade of chalk has been used in the dyeing process. This is another evidence of tradition, as it was believed that it could not under any conditions be replaced. When this chalk was almost impossible to obtain hydrated lime was tried with good results, and now this hydrate is being introduced into the various processes where imported chalk was previously used.

In the dyeing of "Turkey Red," the brightest and fastest of the cotton dyes, lime is used for fixing the alum, and later in the dye bath. In the mordanting of cotton with chromium for the application of alizarin, hydrated lime can be used in place of chalk for rendering the chromium acetate basic. The same is true when using the iron mordant. Logwood, one of the most important black dyes, is fixed in a 2% bath of hydrated lime previous to the treatment with acetate of iron solution, and again after this treatment to render the iron in a basic and insoluble condition.

Bleaching Solutions

Next in importance to the lime boil we have the manufacture of bleaching solution, commonly called chemic. For this, either the unslaked lime or hydrated lime can be used. A suspension of one or the other is made in water contained in a tank fitted with an agitator. The chlorine is liberated from the bottom of the tank in such quantities that the temperature of the solution does not rise above 20 degrees centigrade. The ratio is 0.8 pounds of unslaked lime, or 1.1 pounds of hydrated lime, to 1 pound of chlorine. This is more economical than when prepared from bleaching powder, and the low alkalinity of the solution gives a more efficient bleaching strength.

The kiers used for the clearing of textiles should be lined, so as to prevent the goods from coming into direct contact with the iron. The most satisfactory lining compound is a milk of lime solution. The sides of the warm kier are given a good coat and the kier steamed to fix it. This is followed by a second coat and steaming, after which it is ready for use.

While at the present time the lime boil offers the greatest use of lime in the textile industry as we come to more appreciate the value of lime, other processes will make greater use of it.

Limestone in North Carolina

A RECENT ADDITION to the literature on the lime and limestone industries of the United States is Bulletin No. 28 of the State Geological and Economic Survey on the "Limestones and Marls of North Carolina." This 212-page book describes briefly the various uses of lime and limestone and describes in detail the characters of the deposits of these materials and various operations.

A New "Wet" Process of Lime Manufacture

Utilization of Hot Water Vapor to Open Pores in Limestone and Facilitate Calcination at Temperatures That Do Not Overburn the Lime

By Nathan C. Rockwood

FROM TIME IMMEMORIAL limestone has been *burned* by more or less the same process. Even today, when the process is quite thoroughly understood, and is recognized as a *chemical* process, it is still referred to in the phraseology of lime manufacture as *burning*.

Fundamental Principles

Limestone is the carbonate of lime—$CaCO_3$. Lime is the oxide of lime—CaO. The carbonate is changed to the oxide by exposure to heat. The heat is absorbed and a division is effected between the carbonate and the gas, carbon dioxide—CO_2. Carbon dioxide in the presence of water (or steam) will presumably unite with the water and form carbonic acid—H_2CO_3 (which is a very unstable compound).

To change limestone to lime requires heat at a certain temperature and a certain definite quantity of that heat. It has been pretty accurately determined that the lowest temperature at which this change—calcination—takes place, at normal atmospheric pressure, is 610 deg. Centigrade (1130 deg. F.) and a temperature of 1000 deg. C. (1832 deg. F.) is sufficient to change any limestone to lime.

It has also been definitely determined that limestone will decompose into lime and carbon dioxide more readily in the presence of steam than in a dry atmosphere. Herzfeld, a German investigator, proved limestone could be entirely changed to lime by the heat of superheated steam at 790 deg. C. (1454 deg. F.), which is at least 200 deg. C. lower in temperature than required when a dry heat is used.

The reason why the presence of water vapor facilitates the separation of the carbon dioxide from the limestone is not fully understood, apparently. We do know, however, that limestone is somewhat soluble in water containing CO_2 (carbon dioxide) or in other words in a weak solution of carbonic acid.

A Possible Explanation

When water vapor, or steam, is present in a lime kiln above the actual burning or combustion zone, it is at a very high temperature and possibly combines readily with the CO_2 being given off by the limestone, forming hot concentrated carbonic acid. This hot acid would then attack the limestone immediately and vigorously, partially dissolving the limestone and converting it into calcium bi-carbonate (or di-carbonate).

The calcium bi-carbonate—$CaH_2(CO_3)_2$—forming on the surface of the limestone, being of greater volume than the substance of the stone itself ($CaCO_3$) would tend to crack and open up the stone to the action of the heat, thus making its decomposition more easily accomplished. The surface coating of this newly formed calcium bi-carbonate, however, is much more unstable, or more easily decomposed than the carbonate, and consequently is probably (like the carbonic acid) only momentarily present in the kiln.

The presence of water vapor (steam) in the zone of the kiln above or beyond that in which the final calcination of the stone takes place, does then, in all probability, have a distinctly useful purpose and very likely passes through a definite chemical reaction which greatly facilitates the subsequent reaction in the remaining calcium carbonate with heat alone. The effect of the water vapor and carbon dioxide (H_2CO_3—or carbonic acid) is then exactly the opposite of that produced by a harsh, dry heat, suddenly applied, which has a tendency to sear or glaze over the surface of the limestone, making it difficult for the heat to penetrate and decompose it.

Another Possible Explanation

Silica is the commonest impurity in limestone. Under the microscope ordinary pulverized limestone appears to be composed of "hard-shelled" grains. Probably *they are* "hard-shelled" grains, each particle of calcium carbonate being separated from its neighbor by a film of silica or some silicate of calcium or other alkali. This is the cement which holds the particles of stone or purer carbonate together in a homogeneous mass.

When limestone containing silica (and *all* limestone contains some silica) is heated to high temperatures with dry heat the silica readily fuses with the lime as a flux, possibly forms new chemical combinations, but in any event stays with the lime and when the lime cools remains as a shell or coating on the lime (calcium oxide) particles, just as originally it formed shells for particles of limestone or calcium carbonate.

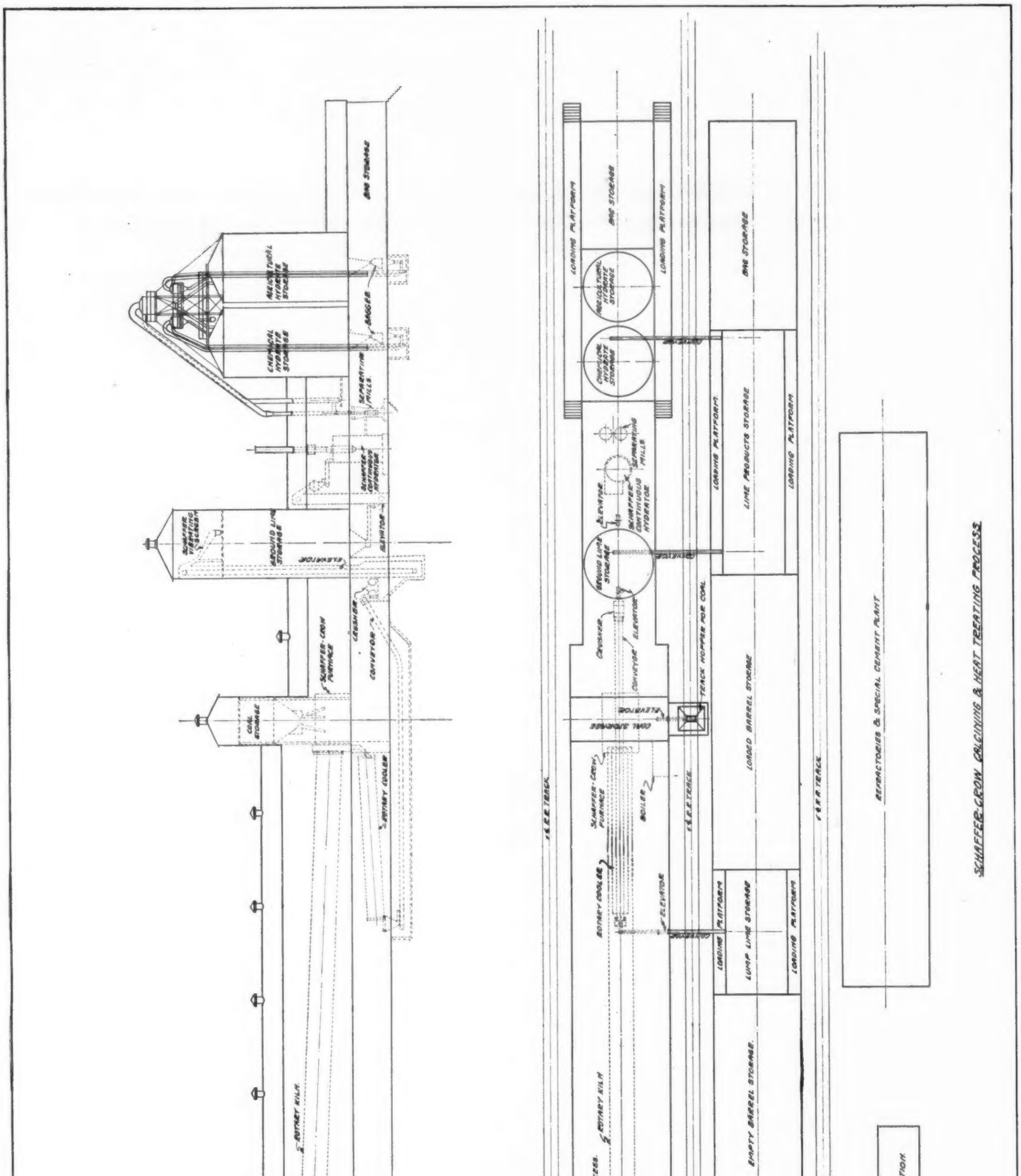
When limestone is heated in a dry heat and the silica fuses, at the same time the CO_2 is being driven off, the natural tendency of course would be for the liquid silica or silicate to be forced to surface of the stone; or, in unscientific language, the stone would "bleed" molten silicate. The tendency of this to follow the CO_2 gas to the surface of the stone would obviously retard the exit of the CO_2 gas, and also make it increasingly difficult for the heat to penetrate into the interior of the stone.

Now, this is just exactly what experience in "burning" limestone shows, for the more intense the heat and the faster the stone is calcined the more it becomes "gummed" up with these silicates. If the "burning" is sufficiently prolonged each lump of lime will be "glazed" over—and it is recognized as "over-burnt."

While silica itself is insoluble in water, or water vapor in the form of steam, the alkaline silicates are quite soluble. Water glass, or a sodium silicate water solution, is a well-known example. Similarly, calcium silicate is undoubtedly very water soluble at high temperatures. The presence of calcium silicate in the water of natural hot springs is proof of its solubility.

Therefore, when superheated steam is present in or above the calcining zone of a lime kiln the silica in the limestone is very likely changed to a soluble calcium silicate, which at the high temperature of 1,000 deg. C. in all probability would be volatilized and carried higher into the kiln, where on cooling the silica or silicate would be precipitated out of the gases and be carried out at the top of the kiln as fine dust or "smoke."

A glimpse of something like the reaction that may take place in a lime kiln in the presence of superheated steam is shown in the manufacturing process of sand-lime brick. In the brick mixture the proportions of lime and silica are about reversed, but the process involves the melting and fusing of the lime and silica (calcium silicate) at temperatures



Diagrammatic layout of a lime plant utilizing the new "wet" process of lime manufacture

of steam not over 200 deg. C. It therefore seems fair to assume that at temperatures of superheated steam at 800 to 1,000 deg. C. the silicate would really be volatilized and freed from the limestone, or lime, as the case may be.

A similar reaction of silica in the presence of steam undoubtedly takes place during the hydration of lime, and that is why it is so important to break up and stir the lime during the hydrating process. The silica present in the lime is being fused and re-arranged, but it emerges from the reaction as "shell formations" about particles of hydrate or unhydrated lime. If the particles are relatively coarse the hydrate is "crystalline" and not desirable. But if the particles are fine the silica is so thoroughly, *or so thinly*, distributed over the immensely larger surface area that it is ineffective in keeping the particles apart, or distinct, and we get the much desired "amorphous" hydrate.

Water An Active Chemical Reagent

It must be confessed that the foregoing theories need demonstration for their whole proof, but the point is that water, in the form of superheated steam especially, is a very powerful chemical reagent. That fact seems to have been lost sight of in the lime industry, where the application of steam to kilns appears to have been considered only from the angle of its mechanical effect on kiln draft, or its tempering or "mellowing" effect on the fire.

Effect of Various Methods on Quality of Lime

From the foregoing, it may be seen that there is a possibility of demonstrating the superior economy of operating a kiln with steam present above the fire zone. There is also a tremendous difference in the quality of lime turned out. For example, Herzfeld, in the experiments already referred to, proved that lime calcined with superheated steam at 790 deg. C. (1454 deg. F.) was extremely high grade —porous, chemically active, and most easily hydrated. He and many other experimenters have also proved that the qualities of lime depreciate in some proportion relative to the temperature of calcination. The higher the temperature the less active the lime and the harder it is to hydrate. The difference is less pronounced in the case of high calcium limestones than with dolomites, because magnesium oxide is more sensitive, apparently, than calcium oxide.

Wood-burned lime is usually a better lime—more active and more easily hydrated—probably because of the large amount of water vapor present in the kiln. (Ordinary hardwood fuel is about 25 per cent water.) This not only prevents an excessively hot fire, but furnishes the water vapor for facilitating the kiln reactions.

That the water in wood fuel is the chief cause of "mellowness" of the heat in a wood-fired kiln is practically proved by the fact that producer gas with a plentiful supply of steam will give nearly the same results. For the same reason peat makes an excellent fuel for calcining limestone.

Commercial Application of This Principle

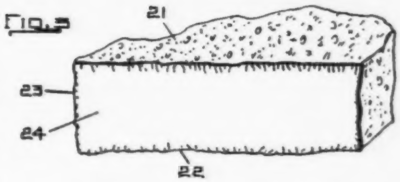
Most of what has gone before is an attempt to explain the reason for some well established facts. What follows is the application of these facts and something the same theory to the commercial production of lime by a new process. Patents Nos. 1,377,367 and 1,377,401, issued in 1921 John C. Schaffer and Waller Crow, of the Schaffer Engineering and Equipment Co., Pittsburgh, Pa., and No. 1,291,425, issued to Mr. Schaffer in 1919, cover a commercial application of the principles already described both as to process and apparatus.

The process involves crushing and grinding the limestone, mixing and grinding it with water in a tube mill to form a slurry, and calcining the slurry in a rotary kiln of about 175-ft. length. This stage of the process is described as follows:

"This slurry or paste supplied to the rotary kiln is heated and agitated in its progress through the kiln. This action upon the paste serves to cause the material to gather into nodules of approximate uniformity in size due to the tempered or mild heating for the gradual elimination of the moisture. The continued heating of these nodules evaporates the moisture from the limestone, resulting in these nodules being quite porous, thereby providing large areas for heat exposure in the elimination of the carbon dioxide, when the calcium carbonate is converted into calcium oxide at the still higher temperature approaching the range for moisture vapor decomposition.

"The rotary kiln of slow rotation has its interior refractory walls, where exposed, heated, so that with the charge of slurry falling thereon at the higher, or feeding end of the kiln, a driving off of moisture occurs, leaving the solid of suspension as a caked material. This deposited mass of material, with the counter current of gases over it has its upper or exterior exposed surface also acted upon. These two direct and radiant sources of heat co-act to the extent that in the kiln rotation, the drying mass of material may progress by falling forward, due to the inclination of the kiln.

"This fallen mass, or fragment, ruptures or subdivides, say, to form a body as shown in Fig. 3, having the more thoroughly seasoned face on what was the



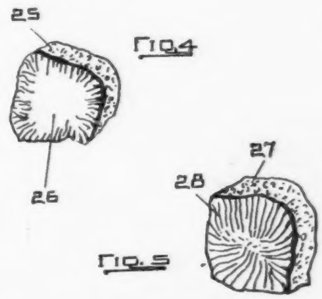
Diagrammatic sketch of cake

upper surface (21), the slightly less seasoned, or dried, lower surface (22) and the fractures (23) from which the moisture has just started to be driven off, or extracted. The interior (24) is fully charged with the gases to be removed.

"Continued slow rotation of the kiln effects a tumbling progress downward in the kiln away from the charging end, with a slow extraction of the gases by the heat. The mass thus held together by moisture is transformed into porous nodules, and this 'nodulization' increases the volatilization area over that of a non-porous nodule or broken-stone formation.

"The continued extraction and tumbling of the material in the kiln effects a more or less uniform production of particles or nodules, which, depending on the character of the material, may be such as would pass, say, through a ¾-in. screen. Such a particle, shown in cross-section in Fig. 4, has its bounding surfaces (25) 'seasoned,' or approximating a semi-porous state, retaining a definite form with the interior still unchanged calcium carbonate. This gradual seasoning or tempering-like action is carried on to the full extraction of both the moisture and carbon dioxide, as shown in Fig. 5, with somewhat more open but still definitely formed faces (27) and a permeated interior (28) as shown in the supposed cross-section of this nodule.

"This continuous or progressive treatment in a 'reducing' heat from the furnace at the lower end of the kiln, due to the gradual rise in temperature throughout the length of the kiln, in a range approximating 1800 deg. F., at the discharge end to 500 deg. F. at the slurry charging end, insures a superior quicklime product with the utilization of the entire run of stone quarried.



Diagrammatic sketch of nodule

Kiln Action Explained

"The carbon dioxide has an affinity for water, which results in the formation of carbonic acid. This carbonic acid gas largely comprises the vapor bath, or atmosphere, enveloping the tumbling nodules. As the temperature is higher toward the discharge end, the atmosphere in the kiln is one of gradually increasing, tempering action. Accordingly, at the relatively low temperature at feeding or upper end of the kiln, there is moisture extraction. At the intermediate kiln portions this extraction is coincident with, or merges into, carbon dioxide extraction at such rate that the nodules as units persist as porous lumps, rendering possible a uniform rate of gas removal.

"With kiln temperatures below excessive or harmful *burning* points, a superior grade of quick lime is produced. The particles are all relatively small, all are uniformly tumbled about in the kiln. The extended exposed surfaces, with the tumbling insuring presentation of all surfaces during a rotation, permit of rapid production of a finished product with no loss in handling. The production rate on a 175-ft. kiln may run as high as 12 tons per hour.

"The commingling or mixing of the charge, if the material itself in a mastic state will not properly form, is insured by the use of a plastic material, which may be refuse sweepings or some alkali hydrate as may be more readily available, or may be desired in standardizing the product.

"The effective, thorough burning, as described, produces a superior product, rapidly, with all quarry stone, but the advance in the art does not end here, for the hydration of the resulting lime may be most easily effected, even direct without sorting or grinding, and the resultant hydrate will take up 25 per cent more water than usual with hydrates burned in ordinary shaft kilns.

"This added water-carrying quality means that a *hydrate* of superior quality is attained—one which has great smoothness for wall application and absence of check after being applied."

Special Furnace

One of the special features of the rotary kiln designed to accomplish calcination at the relatively low temperature of 1800 deg. F. is the furnace. This is in the nature of a direct-connected gas producer, which may be moved to and from its position at the end of the kiln, as is the hood of an ordinary rotary kiln.

This furnace is covered by a special patent and could be applied to any rotary kiln. It has an automatic coal feed and stoker, automatic grate rocker, and automatic ash discharge. Hot air from the lime discharge chute is used to aid combustion in the furnace. Steam lines are provided to temper the heat and accelerate the draft.

Instead of the production of an oxidizing flame, or oxidizing combustion gases for introduction through the large discharge opening of the rotary kiln, the heating gases may have their combustion proportioned to fall more or less short of complete combustion until well along in the kiln, thereby distributing the heat and tempering the initial intensity for a given supply or volume. This adjustment can be accomplished by means of the air intake or by actually controlling the amount of heated gas allowed to enter the kiln.

In other words the furnace is a portable semi-gas producer with many mechanical appliances for automatic operation and designed to be so controlled that the amount, quality and temperature of the heat produced can be changed as desired.

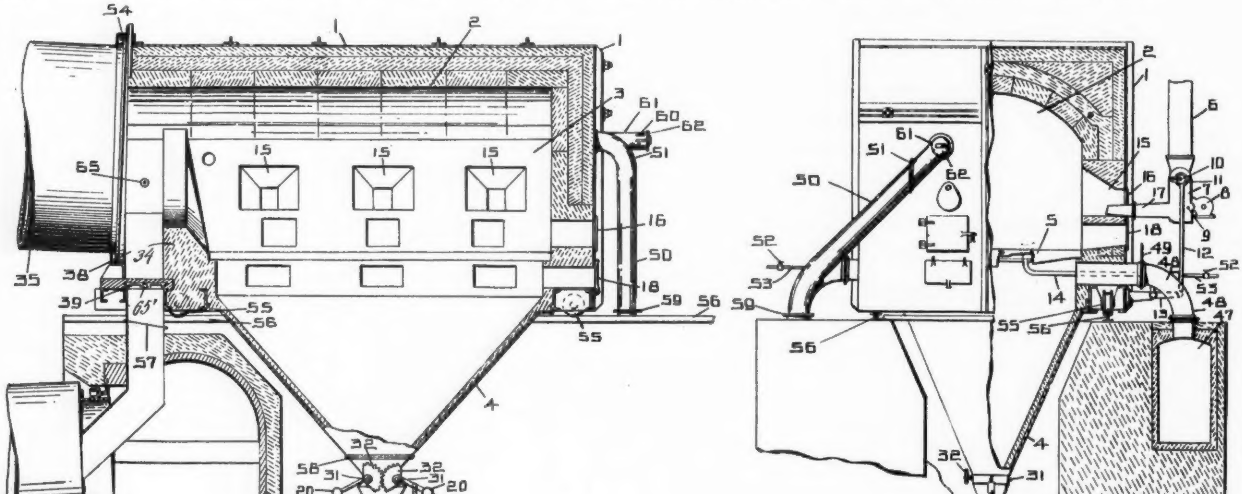
Plant Under Construction

It is of peculiar interest and significance that the dean of the American lime industry and one of the earliest manufacturers of chemical lime, A. G. Morris, president of the American Lime and Stone Co., Bellefonte, Pa., is making the first installation to try out this new process of lime manufacture.

Space will not be taken here to describe this new plant. Its completion will be awaited with much interest by the entire lime industry and at that time we expect to be able to publish a full and complete description.

Great Saving in Phosphate Possible by New Process

A new method of controlling losses of low grade phosphate rock, devised by the United States Department of Agriculture, consists in mixing the "run-of-mine" phosphate with sand and coke and smelting the mass in an electric or fuel-fed furnace. In this process, the phosphoric acid is driven off as a fume and may be readily collected in concentrated form. Millions of tons of phosphates previously wasted will be saved potentially as a result of the perfection of this process.



Diagrammatic sketch of kiln furnace with patented features

Lime in Leather Manufacture

Probably Used for Thousands of Years and It Has No Substitute Today

By Allen Rogers, Ph. D.
Laboratory of Industrial Chemistry, Pratt Institute, Brooklyn, N. Y.

SINCE those far off days in the Garden of Eden, the skins of animals have contstituted a covering for the human race. Even that good and authentic book, the Bible, mentions this fact in the passage which states that "The Lord God made coats of skins and clothed them." Just how this condition became necessary is not stated, but we have reason to believe that the wearing qualities of the fig leaf did not satisfy the thrifty Adam, while no doubt also the beautiful color effects which Nature had given to the coverings of the various lower animals appealed strongly to the vanity of Mother Eve. So it came about that the manufacture of leather was the first industry to be established, and from that day on the pelts of animals have contributed to the comfort and welfare of mankind.

According to Nature's provision, the skins of most animals are covered with hair varying in thickness and length depending upon the environment of the animal, the purpose being to protect him from the climatic conditions to which he is subjected. Primitive man utilized the pelts of animals as they came to him from Nature's workshop, but as he became more civilized, he tried to improve upon Nature's products, and so we find in our early historical records mention of the *curing* of leather. Furthermore, the archeologist has uncovered in ancient ruins well preserved specimens of leather showing that the hair had been removed in the process of manufacture.

Investigation into the ancient methods of dehairing shows quite conclusively that the first process employed was in reality a form of *incipient putrefaction,* which was originally observed, no doubt, through accident. It is well known that during the decomposition of a hide the first signs of putrefaction are detected by the "slipping" of the hair. Depilation through putrefaction is still employed by many tanners of acid hemlock sole leather and by the felmonger in the removal of wool from sheep skins. This process is known in the trade as "sweating."

Origin of the Use of Lime

Another process for the removal of hair was destined to come forth and in a strange manner through an unusual source, namely, through architecture. A pelt, accidentally dropped into a lime pit during the building of some of the structures of ancient times, was, in all probability, observed to present a very striking appearance in that it became swollen and its hair loosened. This discovery led to a new method for dehairing which was much more satisfactory and obviated the well known dangers encountered during putrefaction. The *liming* of pelts thus became well established and from that time on constituted the principal method of depilation.

> **Introductory Note**
>
> **ROCK PRODUCTS has been three years inducing Dr. Rogers to write this summary on the use of lime in tanning. For Dr. Rogers is an extremely busy man. During a large part of that time he has been making extensive researches into the leather industry and developing a method of making leather from shark skins.**
>
> **Dr. Rogers is recognized the world over as one of the greatest of industrial chemists. He is an authority on leather chemistry and ROCK PRODUCTS readers are particularly fortunate to get this brief but exceedingly interesting paper from his pen.—Editors.**

The application of lime for unhairing is very simple and absolutely safe, on account of the fact that lime has only a limited solubility, and any excess present remains inactive toward the hide substance. Lime also being a mild antiseptic, has the further advantage of preventing the decomposition of the pelt as long as it remains in the solution.

In speaking of *lime,* we refer ordinarily to a product derived from the burning of calcium carbonate, commonly known as limestone, chalk, or marble. During this burning, carbon dioxide gas is driven off from the carbonate leaving calcium oxide, or *builders' lime.* This calcium oxide, when used for building purposes or for the depilation of pelts, must be converted into *slaked lime* by treatment with a requisite quantity of water. The chemical reaction taking place is as follows:

$$\underset{\text{(Lime)}}{CaO} + \underset{\text{(Water)}}{H_2O} = \underset{\text{(Calcium Hydroxide)}}{Ca(OH)_2}$$

In making slaked lime, care must be taken to add the water in small portions at a time, stirring the mass continually, because the chemical reaction starts with a generation of heat which increases as the action proceeds. Water is added until a thick, creamy consistency is secured that is free from lumps. This resulting slaked lime is then kept as a stock mixture for the depilation of the hides, or, as the tanner more commonly calls it, for *"liming."*

In the liming of hides and skins, numerous methods involving variation in concentration and time of treatment are employed depending upon the nature of the pelt and the character of the leather to be produced. A few typical examples of these various methods may be of interest at this point.

Methods of Liming Hides for Various Leathers

In the production of *sole* and *belting leather,* fresh limes are usually employed, the amount of lime used on the weight of the hide being from 10 per cent to 25 per cent. This liming is usually done in a series of *pits,* the hides being transferred or reeled forward each day from the *tail* pit toward the *head* pit. The time usually consumed for this class of leather is from 5 to 6 days. Such a method is considered fairly short for straight lime, the object being simply to remove the hair and plump the stock, without causing any depletion of the hide substance. In such a pit system, the slaked lime is added to the head liquor in accordance with the judgment of the tanner. The excess from the head pit overflows to the next in series, and so on to the tail pit, where the excess still remaining again overflows and goes to waste. Liming handled in this manner insures uniform treatment of the stock and obviates any danger from so-called "putrid limes."

For *harness, strap* and *bag* leather, it is beneficial to obtain a certain amount of flexibility in the finished product. This flexibility is largely dependent upon the lime treatment. This more open or flexible condition is secured by subjecting the hides to a somewhat longer immersion in the limes, say from 8 to 10 days.

In the production of *glazed kid* from goat skins, the nature of the pelt makes it necessary to subject the skins to a fairly long lime treatment, which is usually extended over from 12 to 15 days. Goat skins being very compact, require this long treatment in order to open up the fiber bundles and prepare the stock to receive the subsequent tanning materials.

Glove leather, as is well known, must be very stretchy, which means that during the process of liming a certain amount of depletion must have taken place. This depletion is accomplished by what is known in the trade as "old limes," which destroy

a certain amount of the substance, causing a very open and flaccid condition of the pelt. The time of liming for this kind of stock is usually from 15 to 20 days. In the production of a certain class of glove leather known as "Mocha" and "Caster," an exceptionally long liming is given, usually extending over a period of from 40 to 60 days. During this long treatment, the hair is not only removed, but the grain of the leather is loosened and is subsequently removed on a beam by means of a blunt knife or stick, a process known as "frizing." This same process is also used in the production of *buckskin* leather.

Lime and Sodium Sulphide Process

In the production of *calf skin* and *side* leather for shoe uppers, a certain character of the leather must be present, namely, it must have a fairly tight grain, or what is known as a "fine break." In order to produce this tight grain, tanners have found that a mixture of lime with sodium sulphide gives the best results. The quantity of sodium sulphide used, as well as the method of procedure, vary with the individual tanner. As a rule, however, about one pound of sodium sulphide is used for every five pounds of lime.

Some tanners using lump lime mix the sulphide with the lime at the time of slaking, whereas others dissolve the sodium sulphide separately and add it to the lime pit. In the case of the hydrated lime, the sulphide may be dissolved in the water used to stir up the lime with, or it may be dissolved separately and added to the lime. The most approved lime-sulphide method consists in adding the sodium sulphide to the tail liquors, so that it meets the stock during the early part of the depilating process.

Sodium sulphide has the property of dissolving fine hairs, and, if used in strong solution, will also dissolve the mature hairs. Used, however, in the amount mentioned, it simply aids the lime in producing a rapid depilation and insures the complete removal of the fine hairs. By using lime and sulphide, the time of depilation can be materially reduced, and it is not uncommon to find tanners who are depilating stock for this grade of leather in three days.

Manufacturers of *heavy* leather often use sodium sulphide in the early stages of unhairing in order to eliminate the added expense involved in fine hairing on the beam.

When sodium sulphide is added to milk of lime, the following reaction takes place:

$$Na_2S + H_2O = NaHS + NaOH$$

$$2NaHS + Ca(OH)_2 = 2NaOH + Ca(HS)_2$$

The sodium hydroxide thus produced acts as a strong plumping agent upon the hide, while the calcium sulphydrate formed has a solvent action upon the fine hair.

In the removal of wool from pelts, or the treatment of skins where the hair is of considerable value, a mixture of lime and sodium sulphide in the form of a paste is employed. This mixture is usually made by dissolving sodium sulphide in sufficient quantity of water to produce a 4-degree Beaume solution, and to this solution is added enough hydrated lime or pump lime to make a fairly thick paste. A sulphide mixture of this character, when painted on the flesh side of the skins, acts very rapidly, loosening the hair within a few hours. The usual procedure, however, is to paint the flesh side of the skins and place them in piles, flesh to flesh, the hair being pulled on the following day. The skins that have been pulled in this manner are then usually given a straight lime process in order to better prepare them for the subsequent tanning processes.

In the depilation of goat and kid skins for both shoe and glove leather, where a long lime process is desired, but where the depleting action is to be reduced to a minimum, the tanner often mixes his lime with a small quantity of arsenic sulphide, the form used being natural sulphide or *Realger*, or the synthetic product As_2S_2. Arsenic sulphide has the advantage over sodium sulphide that no caustic condition is produced and, consequently, where excessive plumping is not desired, arsenic can be used with good results.

Growing Use of Hydrate

Owing to the fact that common quicklime, or calcium oxide, rapidly absorbs moisture from the air, producing what is known as "air-slaked lime," it is necessary to keep the product in fairly tight barrels. Even with this precaution, however, the lime is apt to absorb moisture through the cracks of the barrel, with the result that bursting and broken barrels are very common. It sometimes happens that barrels of lime exposed to the action of the weather in freight yards and other places become wet from rain storms, etc., and burst, the action being so violent that fire results occasionally. To avoid the dangers and disadvantages encountered in the use of quicklime, there has recently been put into practice a method for preparing what is known in the trade as "hydrated lime."

This variety of lime is made by adding just the requisite quantity of water to produce calcium hydroxide from calcium oxide. The reaction is carried out in power-driven mixing machines, and the resulting product is a dry powder which is usually packed in waterproof cotton bags with an outer paper wrapper. Lime prepared in this manner may be kept indefinitely without deterioration and, when required for use, may be simply mixed with water and added to the pits. Hydrated lime may be used in place of slaked lime in all depilating processes and is rapidly superseding lump lime in the tanning industry.

Although the principal use of lime in the tannery is for depilation, there are other processes in leather manufacture where small quantities of this material are employed. The quantity, however, is comparatively insignificant, as the bulk of this important product is used in the beam house. As the old saying goes, "Leather is made in the beam house," and it is to the lime primarily that the tanner owes the failure or success of his undertaking.

Irish Deposits of Gypsum

FIVE bores sunk at Knocknacran, about two miles from Carrickmacross, in County Monaghan, early in 1921 proved the existence of a large deposit of gypsum. Bores put down at Lishaboe, County Meath, in prospecting for coal or other minerals disclosed a body of gypsum estimated by an expert of the Department of Geology at 1,000,000 tons. The Farney Development Co., Ltd., is said to have secured the mineral rights over this property and to be building a factory capable of producing 25 tons per day of plaster of Paris. About 1,000 tons of high-grade gypsum have been quarried and are ready for manufacturing. Some large blocks of beautifully colored Irish alabaster have also been secured, and it is reported that the entire output of this product will be taken by the Irish Marble Co., Kilkenny.

Accidents in Cement Rock Quarries

ACCORDING TO reports received by the United States Bureau of Mines from all quarries that produced cement rock in 1920 increased activity is shown in this industry during the year. The number of men employed by cement-rock quarries was 13,251, an increase of 3,805, or 40 per cent, over the previous year.

Accidents during the year resulted in the death of 39 men and the injury of 2,585, showing that for each thousand men employed during a standard year of 300 working days, 2.75 deaths and 182.49 injuries occurred. The corresponding rates for 1919 were 2.66 killed and 231.58 injured. Of the total number of accidents, 21 fatalities and 875 injuries occurred in and about the quarry pits, and 18 fatalities and 1,710 injuries occurred at the outside plants. Non-fatal injuries to men working inside the quarries were due principally to the following causes: 135 to haulage accidents, 121 to falls or slides of rock or overburden, 91 flying objects, 87 machinery, 61 handling rock at face of quarry, 50 falling objects, 36 falls of persons, 35 timber or hand tools, 28 explosives and 23 to drilling or channeling. Of the injuries at the outside plants or mills, 207 were caused by machinery, 194 by hand tools, 179 by falling objects, 178 by flying objects, 145 by burns, 132 by falls of persons and 125 by haulage accidents.

Lime in Manufacture of Alkali

Enormous Tonnage Consumed in Processes

By W. D. Mount, M. E.
Consulting Mechanical and Chemical Engineer, Lynchburg, Va.

HOW AND TO WHAT EXTENT lime enters into the manufacture of alkali can be understood best from an explanation of what the term alkali comprises.

The carbonate, bicarbonate and hydrates of sodium and potassium, and more particularly of sodium, are usually known as commercial alkali, of which sodium carbonate, the soda ash of commerce, is the most common and is produced in by far the greatest quantity.

Enormous deposits of natural soda occur in various parts of the world, particularly in California and British East Africa. The soda in these deposits, known as Trona, has a composition of $Na_2CO_3 + NaHCO_3 + 2H_2O$ and usually contains a considerable quantity of NaCl. These deposits have not been developed to any great extent as yet, because they are located far from the principal consuming centers, and also on account of inadequate transportation facilities. The product, however, is of exceptional purity, and owing to the practically inexhaustible tonnage available, there is no question but that in the near future these deposits will be a very considerable factor in supplying the demands for alkali in the industrial world. At the present time about 50 tons of high quality soda ash are being turned out daily at the plant of the Natural Soda Products Co. at Owens Lake in California. Lime, as such, does not enter directly into these operations.

Manufacture of Alkali

The manufacture of alkali today is one of the world's greatest and most important chemical industries.

The originator of the industry was unquestionably LeBlanc, who died in 1806, some eighteen years prior to the building and successful operation of the first LeBlanc soda plant by MusPratt in England. After the initial plant of MusPratt the industry developed tremendously, and for more than fifty years English manufacturers controlled the world's markets for soda. In 1866 Solvay introduced the ammonia process for the manufacture of soda, the basic reactions of which had been worked out by Dyer and Heming, and others, many years before. This method, owing to the fact that the principal product, soda ash, could be produced at much lower cost than by the LeBlanc process, rapidly gained ascendency until today the great bulk of alkali consumed by the world is produced by Solvay's process. The LeBlanc process has never been used in the United States.

The beginning of the industry in this country should be credited to one of America's great engineers, W. B. Cogswell, who built the first plant in America in the early 80s, at Syracuse, N. Y. This pioneer plant was later followed by the Fords with their plant at Wyandotte, Mich.; the Mathieson company with its plant at Saltville, Va., and the Pittsburgh Plate Glass Co. (Columbia Chemical Co.) with a plant at Barberton, Ohio. Later the Solvay Process Co. supplemented its plant at Syracuse with another large operation at Delray, Mich.; and subsequently acquired a small plant at Hutchinson, Kans. The Pennsylvania Salt Co. also entered the field with large works near Wyandotte, Mich. The latest comer in the field of alkali production is the Diamond Alkali Co., with a plant at Fairport, Ohio.

Enormous Proportions of Present American Industry

The tremendous growth of the industry is well shown by production figures for the year 1918, the last year of the war, when the total output in alkali, as carbonate, bicarbonate and hydrate, reached 2,500,000 tons; in its manufacture 1,625,000 tons of lime were used. In 1918, the total production of lime in the United States, including that used in production of alkali, was approximately 4,800,000 tons; thus it can be seen that the alkali manufacturers produced over one-half as much lime as was used for all other purposes combined.

Alkali enters, in one form or another, directly and indirectly into about all of the products of industry; consequently, as a basic raw material, its importance can hardly be under-estimated.

Limestone is burned in connection with the manufacture of soda by the Solvay or ammonia process for two purposes; as a source of CO_2 (carbon dioxide) gas for carbonating ammoniated brine, and to furnish lime used in a secondary distillation process for recovering ammonia. Disregarding the intermediate steps for the reaction, the essential and final result in the carbonators of treating the ammoniated brine with CO_2 gas is bicarbonate of soda and ammonium chloride. The last mentioned is in solution, and represents that portion of the decomposed raw material, salt. The bicarbonate, precipitated, together with the ammonium chloride above referred to in solution, is drawn continuously from the carbonators; the bicarbonate is separated by filtering and the filtrate sent direct to the stills, where the ammonia is recovered by distillation with *lime*, according to the reaction:

Ammonium chloride + *lime* = calcium chloride + ammonia.

The bicarbonate is delivered directly from the filters to large furnaces where it is converted by calcination to monocarbonate, or the soda ash of commerce.

Not all of the producers of soda ash in this country manufacture the hydrate, but those that do convert the carbonate to hydrate by causticizing with *lime*, according to the reaction $Na_2CO_3+Ca(OH)_2=2NaOH+CaCO_3$. The operation is carried out usually in large open tanks equipped with mechanical agitators and arranged so that steam can be blown in for heating. For this operation, also for that in recovering the ammonia by distillation, high calcium lime is required. In the latest and most approved methods of causticizing the operation is carried on continuously.

The carbonate in solution, together with the calcium hydrate in the form of a thick *milk of lime*, is pumped continuously to the causticizer, which in this case is a closed vessel, heated with steam blown in at the bottom. The caustic or sodium hydrate liquor, together with the lime sludge ($CaCO_3$) is delivered continuously to decanters, from which the clear solution of hydrate is drawn from the top and the precipitated lime sludge from the bottom; the latter is delivered to rotary vacuum filters where it is washed and dried.

The hydrate from the decanter goes direct to multiple-effect evaporators for concentration, thence to large open cast-iron pots, where it is further concentrated and heated to a temperature of nearly 500°C., or until the hydrate is actually fused.

After partial cooling the still molten hydrate, which is as clear and limpid as water, is either pumped or syphoned into sheet iron drums, which hold about 800 lbs. The product quickly solidifies in the drums, which are sealed air tight, and the product is then ready for shipment as the hydrate or caustic soda of commerce.

The soda pulp manufacturers are also large users of lime for causticizing soda ash in the manner above described, the resultant hydrate liquor after settling being run direct to the digesters.

Lime in Water Purification

St. Louis Uses 15,000 Tons Annually

By August V. Graf
Chief Chemist, St. Louis, Mo., Water-Works

LIME as a water softener has been in use since its value for that purpose was discovered by Clarke in 1841. From that time, the practice of water softening has increased so that not only the comparatively small amount of water used for boiler and laundry purposes, but entire city supplies are now softened as is the case at St. Louis, Columbus, Grand Rapids and numerous smaller cities. The use of lime as a water purifier and disinfectant and as an aid in the coagulation of ferrous sulphate has been of comparatively recent origin.

Water Softening

As a rule, the saving in soap alone effected by the softening of a hard water supply will more than pay for the added expense incurred in softening. At St. Louis the average reduction in hardness, due to the use of lime, amounted to 83 parts per million for the year 1920. The saving in soap, based on a price of 8 cents a pound, amounted to $1.33 for every thousand gallons of water used for washing purposes. Allowing one gallon per inhabitant per day as the average quantity used for laundry work and bathing, the total saving per day amounted to $1044, or $381,060 for the year.

Besides the saving in soap, the reduction in hardness must also be credited with a reduction in the use of coal by decreasing the amount of scale formed in boilers. Less trouble is also experienced in the clogging of hot water supply pipes, water backs and hot water heaters.

Lime a Sterilizer

The value of lime as a disinfectant and sterilizer of water supplies has been thoroughly demonstrated by Houston in England and Hoover in America. To disinfect a water with lime, the amount of free or caustic lime in the water must, as a rule, be greater than it is advisable to have in a water furnished to the mains.

The value of lime for water-works purposes depends upon its calcium oxide content. As the calcium oxide content decreases, the amount of unburnt and overburnt lime, silica, magnesium increases and the lime becomes less valuable not only to the extent of the decrease in the calcium oxide content, but the larger amount of inerts means the handling of larger amounts of material and a greater amount of sludge to remove from the slaking tanks.

Tests were made at this plant to determine the effect of lime of varying percentages of calcium oxide upon the amount that could be slaked before the slaking tank had to be taken out of service. Seven tests were made and the results showed that for every increase of 1 per cent in the available calcium oxide, above the lowest lime tested, an additional ten tons could be slaked.

Where the lime is weighed out by automatic scales, it is of importance that the lime should not contain too much fine lime. Fine lime will continue to flow after the chute supplying the lime to the scale is shut and cause a bridging of the lime which will interfere with the dumping of the scale. Lime, to be weighed out by automatic scales, should be crushed at the water-works to about 1½-in. pieces. If the lime is too soft too much fine stuff is produced at the crusher and in the storage bins.

Hydrated lime is used in a great number of the smaller plants and is measured out by dry feed apparatus. The use of this form of lime and the method of feeding is a good deal less troublesome than where quicklime is used and is to be recommended.

Specifications for Lime

The following are the specifications for lime used by the St. Louis Water Works: The material delivered under this contract shall be well burned lump lime free from cores. All lime furnished shall contain 85% pure calcium oxide and not more than 1.3% magnesia, magnesium oxide. The contract price shall be paid for each car containing 85% pure calcium oxide and less than 1.3% magnesium oxide. Should the per cent of calcium oxide be greater or less than 85.1½% of the contract price will be added to or subtracted from such price for each per cent the amount of pure calcium oxide exceeds or is less than 85%. Should the sample from any car show more than 1.3% of magnesium oxide, the price paid for that car shall be the contract price decreased by 1% for each 0.1% of magnesium oxide that the sample contains in excess of 1.3%. Both corrections in the contract price shall apply against the same car when the per cent of calcium oxide present shall vary from 85% and when the per cent of magnesium oxide present shall exceed 1.3%. All calcium oxide will be figured to the nearest one per cent and all magnesium oxide to the nearest one-tenth of one per cent.

In the specifications of lime issued by most cities no mention is made as to the magnesium oxide content of the lime and no penalties are provided.

During the year 1920, the St. Louis water-works used 15,000 tons of lime, the average calcium oxide content being 84.4%. The price per ton of 85% calcium oxide lime varied from $11.30 to $14.55. Of the 446 cars of lime received during the year, 94 cars showed a per cent of calcium oxide greater than 90 and 225 cars greater than 85, the amount required by our specifications.

In purchasing lime, the method of analysis used in determining the amount of calcium oxide present in the car sample should be included in the specifications. Several methods of analysis are in use and to insure against any dispute as to the calcium oxide content of the lime, the same method should be used by both manufacturer and buyer.

Gypsum and Soil Acidity

THERE IS a general belief among farmers and also among some investigators that gypsum causes an acid condition in the soil. This idea probably originated from text books on fertilizers and manures, or by confusing ammonium sulphate, one of the common nitrogen fertilizers, with calcium sulphate. It is a well known fact that ammonium sulphate when applied year after year produces a very acid condition in the soil. Work done at the Pennsylvania Experiment Station emphasizes this point. The experimental plots of the Pennsylvania Experiment Station contain three ammonium sulphate and two calcium sulphate or gypsum plots in each series. After thirty years from the time these plots were started samples of soil were taken from both the ammonium sulphate and calcium sulphate plots and tested for soil acidity. It was found that in every case the soil from the ammonium sulphate plots showed a decided acid condition. On the other hand, the calcium sulphate plots showed no effect whatever on soil acidity. Since this material was applied at the rate of 320 pounds every two years, and these tests were made thirty years after the first treatment, they show that there is absolutely no danger of making the soil more acid from the use of gypsum.—*Pennsylvania Farmer.*

Manufacture of Chemical Lime

Demand for Chemical Lime Is Revolutionizing the Lime Industry—Scientific Control Fast Coming

By Bernard L. McNulty
General Manager, Mitchell Lime Co., Chicago, Ill.

THE EXACTING DEMANDS of industrial manufacturing has done much to develop the technique of the lime-manufacturing industry and has changed it from a construction and building-material industry to the more exacting status of a chemical industry. More than 50 per cent of the commercial lime manufactured today is used in some chemical manufacturing process.

More progress has been made in the past ten years, in the methods of plant design, construction and operation, than was noted in the previous fifty years. Until the new demand came, requiring large production for highly specialized products, hundreds of single kilns, or small plant units, were operated spasmodically by men who considered lime-burning a side line and therefore conducted it as a "one-man business." Gradually some of these manufacturers developed their plants into larger units requiring organizations made up of men specializing in the various departments of their business, and the smaller plants have one by one disappeared.

Cheapest of Alkalies

In practically every chemical manufacturing industry one of the fundamental necessities is a cheap, strong base alkali or caustic, and lime is the natural answer to this necessity. The exacting requirements of the user, and the keen competition in the lime industry, show the need for this high grade base product, whether it functions as a causticizing, neutralizing, catalyzing, ionizing or a saponifying agent, or serves any of the other very numerous chemical functions which lime performs.

The steps in the manufacture, preparation and selection of this basic chemical, lime, up through its use and function in the finished product, are steps that require technical skill and close scientific supervisory talent in its manufacture.

There are many vast deposits of limestone in this country, but very few are entirely suitable as raw material in the manufacture of lime products.

The lesser elements that are found in chemical combination with calcium (which is the active basic re-agent in most processes) vary somewhat in percentage and nature, but when magnesium, iron, alumina and silica, whose combined content is not more than 5 per cent, are found, it is generally well suited for any ordinary use to which the lime may be put. The producer of lime, however, has no control over the percentage or distribution of these elements in the lime rock, beyond the fact that he can carefully select the rock ledge which, by analysis, gives him the percentages of these minor ingredients, that he may have in the finished product.

Special Considerations in Making Chemical Lime

In the burning of the lime for a chemical use, it is the desire of the manufacurer to maintain a uniform heat in the kiln, and modern plants of today are now giving this matter of heat control careful study. Some kilns have been equipped with pyrometers as an assistance in indicating how to regulate the temperature and keep it under control.

The quality of coal is an all-important study that should be given close attention. Not so long ago it was common practice to use any bituminous coal, but now only the best grades are wanted, and these, while probably more expensive, prove the more economical, in so far as the quality of the coal is reflected in the finished lime product.

To properly regulate the passage of the rock from its raw state in the charging hopper of the kiln, until it has been gradually heated and the carbon dioxide driven off in the firing zone, it is necessary to draw the kiln at regular intervals. If this is not done, the lime in its freshly calcined state would be very active in reabsorbing its own carbon dioxide gas before it had been passed by draught from the kiln.

After the lime is drawn, it is allowed to cool and is then sorted or forked to obtain a uniform grade of material typical of the plant output. In those plants where a large production is handled the lime is mechanically conveyed and passes over picking tables, where pieces not up to standard requirement are thrown out. After the lime is taken from the kilns it is cooled and ready to be shipped in the lump form or as the hydrate.

The lime which goes to the hydrator is ground and scientifically combined with an exact amount of water by chemical predetermination, and through this process a new dry flocculent hydrated lime is produced without either excess water or lime.

Following the hydration process, in which a new chemical is formed, the hydrated lime is passed through a complicated system of air-separation, which produces an excellently finished lime product, with the impurities eliminated.

Differences in Lime

Limes of apparently the same chemical analyses have very decidedly different physical characteristics, which cause differences and sometimes difficulty in the subsequent processes into which they find their use. The chemistry of lime has not been studied sufficiently to determine exactly why this apparent incongruity exists.

For instance, one high calcium lime will settle out more quickly as a caustic; or another lime in the manufacture of bleaching powder will carry more chlorine, and another will bulk to produce a considerable variety of different volumes. Considering these few reasons as typical, it is therefore easily comprehended why users of lime in manufacturing processes are guided more largely by prejudice than by exact technical knowledge of the reasons why various limes act differently; and as a result of this, occasionally a lime user becomes accustomed to using a particular lime which really may prove to be not the proper and most economical product for his special purpose.

Most users of lime consider air-slaked lime as useless or of little value. Air-slaked lime is formed because freshly-drawn lime from the kiln is very unstable and its natural tendency is to form a new chemical compound called air-slaked lime, which is really a complex admixture of the hydrate and the carbonate, the air producing the moisture and carbon dioxide necessary for this reaction. However, for this air-slaking to take place the lime must first pass through the evolutionary form of calcium hydroxide, commonly called hydrate, and as such the deterioration in the utility of the lime is very small, as the hydrate of lime is quite active although less caustic than the basic calcium oxide, or quick lime.

To Solve Manufacturing Problems

In full appreciation of the technical problems involved, both in the manufacture and uses of lime products, the lime industry supports a National Lime Association, which has a chemical department and a laboratory adequately equipped and solely devoted to the research and de-

velopment of lime products and their uses. The technical staff of the association is composed of highly trained men of exceptional ability along the lines mentioned and already they have developed valuable information both for the manufacturer and user of lime. This department works on the problems of the user of lime in his manufacturing processes and its purpose is to determine more about these problems and help the consumer to get more satisfactory and efficient results from lime products, in the belief that the value of any product is after all measured by the service it performs.

A small nominal increase in the price paid for a satisfactory lime is more than offset by its improved utility and function in the finished product. Chemical manufacturers using lime are advised to determine through technical study exactly what their lime requirements are and to insist on getting this product.

Chemistry of the Construction Uses of Lime*

Two Kinds of Hydrates—Where Chemical Control of Manufacture and Properties of Product Meet

By Warren E. Emley
U. S. Bureau of Standards, Washington, D. C.

CHEMICAL CONTROL of manufacture, the use of lime as a chemical reagent—these and similar problems are of absorbing interest to the chemist. We have lately come to realize that accurate control of manufacturing conditions affects the quality of lime; and that the same properties which may make a particular lime good or poor as a chemical reagent may have a similar effect upon its quality as a building material.

The setting, or hardening, of lime is the one chemical reaction of chief interest to the builder. The general principles of this reaction have long been understood: it depends upon chemical combination between the calcium hydroxide in the lime and the carbon dioxide in the air to form calcium carbonate.

Amorphous and Crystalline Hydrate

It is also pretty generally understood that calcium hydroxide may exist in two forms: amorphous and crystalline. Whether one or the other of these forms predominates in a given sample depends upon the manufacturing conditions. The quality of the lime, not only as a chemical reagent, but also as a building material, depends in a large degree upon the relative amounts of the two forms of hydroxide which it contains. Thus the construction uses of lime present many problems of direct appeal to the chemist.

The slaking of lime involves a chemical reaction between calcium oxide and water to form calcium hydroxide. In accordance with the general law on this subject, the more quickly this reaction can be made to take place, the more amorphous and less crystalline hydroxide will it produce. The speed of the reaction will depend upon such factors as the fineness of the grains of lime, their permeability to water, the ratio of lime to water, the temperature of the reacting materials, etc.

There is a natural difference in the fineness of grain of limestones, depending partly on the way in which the limestone was originally deposited, and partly on its subsequent history. It is now known that dolomite, when heated to about 500° C., breaks up into its two constituent carbonates, and it is probable that calcium carbonate made in this manner is finer grained than any naturally occurring form. The size of grain of lime depends not only on the size of grain of the stone, but also on the temperature and duration of burning. Prolonged heating at high temperatures causes the grains of lime to agglomerate.

Chemistry of Hydration

All limestones contain impurities. At high temperatures, these display an acidic character and combine with the lime to form fusible compounds. The fused material is impermeable and prevents the water from reaching the lime and reacting with it.

The presence of an excess of water would, per se, tend to hasten the reaction, but this effect may be overshadowed by the influence which it exerts upon the temperature. The reaction between calcium oxide and water is exothermic. This means that the application of heat to the reacting materials will delay, if it does not stop or even reverse, the reaction. The speed of reaction is therefore increased by keeping the temperature down, and the presence of an excess of water is an easy way to accomplish this.

What effect has the amorphous or crystalline nature of calcium hydroxide on the properties of lime used in construction? We have just seriously begun to look for the answer to this question. It is the present purpose, therefore, merely to outline certain phases of this subject, which are worthy of investigation.

The value of lime as a structural material is largely dependent upon its "fatness," or plasticity. It is thought, but not proved, that this property depends upon the presence of amorphous and crystalline particles in definite proportions. How much of each there should be, we do not know.

Chemistry of Lime Mortar

When examining ancient mortars, made of lime and sand, it is learned that sometimes the lime has combined with the sand, and sometimes it has not. When combination has occurred, the mortar is much denser and stronger. Is the possibility of this reaction affected by the nature of the calcium hydroxide in the mortar?

Hardened portland cement normally contains calcium hydroxide, as one of the products resulting from the hardening reaction. This calcium hydroxide is crystalline. When hydrated lime, consisting almost entirely of amorphous calcium hydroxide, is added to portland cement, is it, in effect the addition of a new material, or is it rather the addition of an excess of a material which is normally present?

It is at least probable that the rate of reaction between carbon dioxide and the two forms of calcium hydroxide will be different. This means that a mortar containing a preponderance of crystalline material will set at a different rate from one containing a preponderance of amorphous material. The time of set of lime mortar is a property of great commercial importance.

The above problems (and many more may be cited) illustrate interesting application of chemical research to the construction uses of lime. The solution of any of them is not only of academic, but also of practical importance; of interest not only to the lime industry, but to the general public as well.

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Lime in Extraction of Potash from Greensand

Cheapest Chemical Reagent—Valuable By-Products

By R. Norris Shreve
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IN THE LIBERATION OF POTASH from greensand, or silicates such as feldspar, leucite or the like, by the action of a chemical reagent, it is necessary that the reagent used be procurable on a large scale at a low price, and it is also almost essential that by-products of value be obtained. These and other conditions are filled by lime in a most satisfactory manner.

A large plant, namely, that of the Eastern Potash Corporation, is now approaching completion, located on the Raritan River near New Brunswick, N. J., where 1000 tons of greensand will be treated every day with 1000 tons of lime in order to liberate the potash in the greensand and to obtain valuable lime by-products.

The limestone, obtained from McAfee, Sussex County, N. J., will be calcined right at the plant in rotary kilns, capable of furnishing 1000 tons of quick lime per day. The hot lime discharged from the kilns will be partly cooled, and then slaked with weak potash liquors. This hot milk of lime will then be mixed with the ground greensand, and the resulting slurry pumped continuously through digesters where the slurry will be kept at 470°F. for an hour to effect the reaction of the lime on the greensand.

After digestion and cooling, the liquor containing the potash in solution will be filtered from the solid lime-carrying residue. The liquor furnishes the potash in a commercial form by simply evaporating off the water. The solid residue is used in its hot moist condition for the manufacture of bricks, or it is dried and powdered for use as a soil liming material.

A number of the buildings of the Raritan plant have had their walls built out of these bricks which present a very handsome appearance besides meeting fully all the tests of building codes. These bricks were made out of this lime residue at the small manufacturing plant which the Eastern Potash Corporation maintained at Jones Point, N. Y., where this complete process has been operated for several years.

When the lime-carrying residue is dried and powdered it furnishes an excellent material for the liming of soils: on account of its high lime content. The New Jersey Experiment Station at New Brunswick is experimenting with this residue, or "Limosil," as it has been named, on a number of crops, comparing the "Limosil" with lime and limestone.

Function of the Lime

The details of the chemistry of the action of lime on greensand are treated by the writer in a current number of the "Journal of Industrial and Engineering Chemistry." In general it may be said that the lime in the presence of water and heat acts to disrupt the greensand (or glauconite), liberating the potash in the form of caustic potash, and forming quite probably calcium monosilicate. Physically the latter is very finely divided.

The reaction takes quite an appreciable time, for example about one hour at 470°-480°F. is necessary to convert about three-quarters of the potash into the soluble form. As an essential to this conversion, the greensand must be very finely ground and the slurry must be kept agitated.

The length of time required can be shortened by violent stirring or by increasing the very small amount of lime that is normally soluble in these hot digestion liquors. The violent stirring is expensive and troublesome to carry out on a large scale when handling a slurry at the temperature of 500-lb. steam (470°F.). However, the writer has been able to accelerate the action of the lime on the greensand by employing various substances that increase the solubility of the lime.

Among such accelerators are sodium nitrate and potassium nitrate. Many other salts have been tried, but these two nitrates are the most feasible from a commercial viewpoint. As carried out practically the nitrate is added to the slurry before it enters the digesters, and subsequently recovered during the concentration of the caustic liquor.

In case of the use of potassium nitrate, the action is simply one of accelerating the action of the lime by increasing the solubility of the calcium hydroxide, as the potassium nitrate is recovered as such, and used over again.

When employing sodium nitrate the following chemical reaction takes place:

$$NaNO_3+KOH=KNO_3+NaOH$$

Thus the sodium nitrate changes to potassium nitrate, and the caustic potash to caustic soda. So here there is effected, besides an increase in yield due to the accelerating action of the nitrates, a change in the form in which the potash is recovered. This is very advantageous as it enables the plant to produce both caustic potash and potassium nitrate. Furthermore in case of the production of the latter, caustic soda is a valuable by-product.

To summarize, the use of lime in liberating potash from greensand, is advantageous for the following reasons:

1. The lime is available in large amounts.
2. The lime is relatively cheap.
3. The resulting lime carrying residue after separation from the potash is useful for brick manufacture, liming of soils, stucco, etc.
4. Caustic potash is the primary product. In this form the potash is more valuable than in most other compounds. It is also very reactive and consequently comparatively easy to change to other potassium compounds, as the market may indicate.
5. The action of the lime is capable of being accelerated by the use of potassium nitrate, sodium nitrates and other salts.
6. The potash compounds obtained are very pure for commercial products.

Cement in China

UNTIL WITHIN a few years ago the only important cement factory in China was the one at Hong Kong. Recently some large corporations have been formed in other provinces among them a Chinese company, the Chee Hsin Cement Co., operating a modern mill with rotary kilns in Tongschan, north of Tientsin on the Pekin-Mukden R. R. The necessary lime originates in the immediate vicinity and only gray cement is produced. The average annual output is 600,000 barrels. Within a year this firm has come to own the Yang-tse-kiang works near Hankau whose product is known under the name of Hupei Portland Cement Co. Its annual capacity is placed at 200,000 barrels. A government owned mill at Kanton has about the same capacity. A few years ago a cement mill was also erected at Chee Foo. Clay beds, discovered three miles southwest of Chee Foo proved on examination to be suitable for the purpose and a million dollar corporation was organized which is endeavoring at present to gain a monopoly of all cement products in the province of Shantung for thirty years.—(From *Tonindustrie-Zeitung*, Berlin, Germany.)

Lime in the Treatment of Sewage and Industrial Wastes

Chemical Precipitation of Industrial Wastes a Growing Field for Use of Lime

By Frank A. Marston
Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

THE TREATMENT OF SEWAGE by sedimentation in tanks is one of the most common methods in use for separating out a part of the solid matters carried in suspension. Even after settling for a period of eight or ten hours, the quantity of suspended solids thus removed may constitute less than half that present in the sewage. It is usually not economical to attempt the removal of any of the remaining suspended solids by sedimentation, and in some cases it is not possible to do so. By treating the sewage with chemicals to form a gelatinous precipitate, much of the remaining suspended matter and colloidal matter can be settled out. The action of the precipitate is more mechanical than chemical. The flocculent precipitate in forming draws to itself and carries down the finely divided suspended matter and colloidal matter, forming a liquid deposit, called sludge, on the bottom of the tank. The process has the same effect as a straining action, carried to a fine degree.

By this method of treatment, called chemical precipitation, if carried out under competent supervision and with favorable conditions, it has been possible to produce a treated sewage, or effluent, that is clear, of satisfactory appearance, and suitable for discharge into streams where it will be diluted with a sufficient volume of fairly clean water. As a rule, the effluent is putrescible, and it is not to be compared with the effluent which can be obtained by filtration through sand.

A number of chemicals have been used for treating sewage, of which, lime, alum, copperas and ferric sulphate are the most common.

Which chemical is used depends on the character of the sewage or manufacturing wastes, the relative cost and suitability of the chemicals, the availability of one of these chemicals as a by-product or waste of the industry (in the case of manufacturing wastes), the extent of treatment necessary, and other factors.

Use of Lime

Lime used in chemical precipitation has generally been commercial quicklime. Hydrated lime, unless it has become air-slaked, could be used, but its cost has generally been rather high for this purpose. A magnesian lime (dolomite) is not suitable, because the active factor in the process is calcium oxide (CaO). It is, therefore, important that the lime used contain a high percentage of available calcium oxide, and that this percentage be determined by analyses. For this reason it will be clear that the value of a lime for chemical precipitation should be reckoned in units of available calcium oxide rather than in units of dead weight.

At the Worcester, Mass., sewage treatment plant, where chemical precipitation has been practiced for many years, standard methods have been developed for testing lime which are applicable elsewhere. The following is quoted from "American Sewerage Practice" by Metcalf & Eddy, Vol. III, p. 450:

Total Calcium Oxide.—Dissolve 0.2 gram of the sample in dilute (1 to 10) hydrochloric acid, keeping the liquid warm until the lime is dissolved. There will be some insoluble matter, which should be filtered out after neutralizing the solution with ammonia. The filtrate is boiled and ammonium oxalate added until the calcium is all precipitated. The liquid is then kept in cold water until clarified, when it is filtered. The residue is dissolved in sulphuric acid and titrated with standard potassium permanganate solution.

Available Calcium Oxide.—Boil 0.1 gram with a moderate amount of water at least half an hour to render the calcium carbonate insoluble. Titrate with 1/10 normal hydrochloric acid, using phenolphthalein in an alcoholic solution as an indicator.

Defects in burning lime naturally render it less valuable for use in chemical precipitation, as in the building industry. Underburned lumps are objectionable because of the unchanged calcium carbonate in them. Overburned lumps contain siliceous materials (impurities) which have been fused, forming a protection to the calcium oxide and retarding the slaking action.

The storage of quicklime involves some care to prevent serious deterioration from air-slaking. The lime should be stored in a weather-tight building where the air can be kept as dry as possible. The process of air-slaking causes the lime to swell in volume and generates heat to the extent of causing fires, so that provision should be made for both of these contingencies in the design of lime storage bins and the building for housing the same. Where the storage bins are left open, air-slaking occurs in the top layer, forming a powder which tends to protect the lime below. In some plants, special movable covers are provided to reduce the air space above stored lime to a minimum.

Process in Detail

Because lime does not dissolve in large proportion in water, it is generally applied to sewage as milk of lime. Quicklime is slaked in a small amount of water, allowed to stand for twelve hours, more or less, and then mixed with a large volume of water, forming a thin milk of lime. A quick slaking lime will require more water than the harder grades.

The milk of lime is added to the sewage in quantities sufficient to neutralize mineral acids or acid sales which may be present and to combine with constituents of the sewage, or with another chemical if such is also added, to form a satisfactory precipitate.

The quantity of lime required varies according to the acid or alkaline character of the sewage or waste to be treated, whether lime is used alone or with some other chemical such as sulphate of iron, and the extent of treatment desired. If too much lime is used, some of the suspended organic matter may be dissolved, making the effluent of much poorer quality.

The extent to which lime must be added may be determined by the use of an alcoholic solution of phenolphthalein as an indicator. When used for this test, a few drops of phenolphthalein added to a sample of treated sewage will show a pink color when enough lime has been added, but care should be exercised to add only enough to lime to produce this result.

Lime has been used at the Worcester, Mass., sewage treatment plant since about 1890. This is one of the few plants, and about the only municipal sewage treatment plant in the United States that has used lime uninterruptedly since the beginning. Not all of the sewage is treated by chemical precipitation. During the year ending November 30, 1919, about 82 per cent of the sewage was passed through the chemical precipitation basins. Granulated lime was used instead of lump lime (as it was considered superior to lump lime for handling), containing an average of 76.4 per cent of available CaO. The contract for furnishing lime required the available calcium oxide to be at least 75 per cent. The total quantity of lime used during the year was 2,466 tons, or 13,511 pounds per day, equivalent to 762 pounds per million gallons of sewage treated. The cost of the lime was $10.90 per ton delivered. In earlier years larger quantities of lime have been required, such as 905 pounds in the year 1912 and 1,233 pounds in the year 1893, per million gallons of sewage treated. The difference is partly due to a reduction in the per-

centage of acid iron wastes present in the sewage and partly to increased efficiency in the operation of the plant.

At Providence, R. I., lime has also been used for some years (not continuously) in the treatment of sewage.

The development in recent years of improved methods of filtration, involving lower costs of operation and more efficient treatment, has led to a practical abandonment in new plants of chemical precipitation as a process for treating sewage. For the treatment of industrial wastes, however, chemical precipitation still has an important place, and therein appears to be the principal field of usefulness for lime.

Lime is used indirectly in sewage treatment for disinfection in the form of chloride of lime or bleaching powder. Of late years, at some plants, liquid chlorine has taken the place of the chloride of lime, but there are some operators who now consider the chloride of lime superior for the disinfection of sewage effluents.

Lime for Refractory Silica Brick

Kind of Silica Required—Function and Use of Lime

By Raymond M. Howe

Senior Fellow, Refractories Manufacturers Association Fellowship, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

DOMESTIC REFRACTORY SILICA BRICK are made from quartzite bonded with a small amount of lime. The quartzite constitutes the major part of the batch and imparts most of the distinguishing characteristics to the finished brick. It is difficult, however, if not impossible, to mold quartzite without the addition of a binder. For this reason from 1.5 to 4.0 per cent of lime (CaO) is used in the batch to impart the necessary strength.

The quartzite used is found in Pennsylvania, Wisconsin, Alabama, Colorado, California and adjacent territory. It may occur either as talus or solid measure. It is hard and tough and breaks up into irregularly shaped particles of varying size. It may be white, pink, grey or black in color. Quartzite has a specific gravity of 2.65. It melts at about 1725°C. The following analyses[2] are typical of the quartzite now being used in the manufacture of refractory silica brick:

ANALYSES OF DIFFERENT TYPES OF QUARTZITE

	Medina	Baraboo	Alabama
Silica	97.80	97.15	97.70
Alumina	.90	1.00	.96
Ferric Oxide	.85	1.05	.80
Calcium Oxide	.10	.10	.05
Magnesium Oxide	.15	.25	.30
Alkalies	.40	.10	.31

Very little has been published regarding the lime used in this industry. High calcium lime has been used almost exclusively and it is unlikely that low calcium lime would give satisfaction. It is an open question as to whether lump or hydrated lime is more satisfactory. Manufacturers prefer not to use lime which is badly air slaked.

The following analyses[1] represent the maximum, minimum and average percentages of each constituent in fourteen samples examined by the writer. These samples are representative of the lime which is used in the Pennsylvania, Wisconsin, Alabama and Colorado districts:

	Maximum	Minimum	Average	Avg. on zero ignition basis
Ignition	24.48	6.54	17.60	.00
Silica	4.20	.48	1.58	1.96
Alumina and Iron Oxide	1.00	.32	.56	.68
Calcium Oxide	91.71	70.55	79.03	95.72
Magnesia	5.67	.55	1.37	1.64

Before discussing the relative merits of different kinds of lime, let us consider the process of manufacture of silica brick. The quartzite is first ground in a wet pan until the particles vary from "dust" to ¼-in. size. Lime is then added as milk of lime, the batch is molded and the shapes are allowed to dry. The bone-dry pieces are then burned in round down draft kilns until most of the quartzite has been converted into tridymite and christobalite. The bricks expand during this conversion.

The lime must impart a certain amount of plasticity to the otherwise non-plastic batch; it must bond the bone-dry shapes so that they may be handled and support considerable weight in the kiln; and it must bond the burned bricks so that they may be shipped, installed and used. It also aids in converting the quartzite to tridymite and christobalite.

Little or nothing has been written regarding the plasticity of silica mud batches. The plasticity may be controlled by the plasticity of the lime or by the size of the quartzite grains. The batch at its best does not possess as high a plasticity as might be desired, and, accordingly, in Europe, it is common practice to add 1 or 2 per cent of very plastic clay to improve its working properties.

May Use Air-Slaked Lime

Some very simple experiments were performed recently in this laboratory in order to learn the influence of lime upon the "green" strength or the strength of the bone-dry brick. Bricks were bonded with fresh lump lime and with the same lime after air-slaking for two months. Fresh and exposed hydrated lime were also used under the same conditions. The average cold crushing strengths of the green brick were 99, 111, 102 and 108 lbs. per sq. in., respectively. Thus, it is evident that there may be considerable leeway with respect to the lime used, so far as the dry strength of the bricks is concerned, for these differences were too slight to be considered as significant.

Similar experiments were made in order to study the influence of lime upon the strengths of the burned brick. The results indicated that air-slaking did not impair the lime for this use, so long as allowance was made in the amount of lime used for the degree of slaking. The bricks made from lump lime were stronger than those made from hydrated lime. The consolidated figures indicated, however, that the quantity of calcium oxide in the brick was of more importance than the type of lime in determining the strength of the burned brick.

Lime exerts another very important influence upon the quality of a silica brick. The raw material has a specific gravity of 2.65, yet the specific gravity of the burned brick may be as low as 2.28. Consequently, silica brick at a high temperature may continue to expand (decrease in specific gravity) so long as the specific gravity is above 2.28, and in so doing may cause trouble. Lime, at high temperatures, aids materially in the inversion of the quartzite to the lighter forms of silica. Since this is the case, and the action takes place most rapidly at the surface of the silica grains, it is quite possible that the most finely divided lime might be of the greatest value from this standpoint. This statement, however, is based entirely upon the assumption that it would come in contact with a greater surface area of quartzite. It is quite probable that a study of this influence and that of the plasticity of the lime might yield some very interesting and practical information.

The limes which are highest in calcium oxide are regarded at the present time as being the best for this purpose. The following rough limitations calculated to zero ignition indicate the requirements of the silica brick industry:

SiO_2	Under 3.00 per cent
$Al_2O_3 + Fe_2O_3$	Under 1.25 per cent
MgO	Under 2.00 per cent
CaO	Over 95.00 per cent

Additional preferences as to the plasticity of the lime and its size of grain may result from a more intensive study.

[1]Analyses by R. F. Ferguson, Mellon Institute.
[2]K. Seaver. Trans. Am. Inst. Met. Mining Eng. 53, (1916), 125-139.

Practical Chemistry for Lime and Cement Manufacturers

Aluminum, Clay, Iron, Copper and Some of the Other Metals

By Richard K. Meade, M. S.
Consulting Chemical and Industrial Engineer, Baltimore, Md.

ALUMINUM is the most widely distributed of all the metals as it is an important constituent of such common minerals as feldspar, granite and mica and in many products resulting from the decomposition of these such as clay and kaolin. The ore from which aluminum is obtained, however, is *bauxite*, or hydrated oxide of aluminum, $Al_2O_3 . 2H_2O$.

Aluminum is now quite cheaply prepared by the electrolysis of aluminum oxide, obtained from bauxite. This is dissolved in a bath of fused cryolite, a mineral consisting of a double fluoride of aluminum and sodium with the formula $AlNa_3F_6$. The properties of aluminum have been mentioned previously and the only compounds of this metal of interest to cement and lime manufacturers are the oxide and clay.

Alumina

Alumina oxide, Al_2O_3, commonly called alumina, occurs in nature in the form of ruby, sapphire and corundum, all of which are extremely hard minerals. It is obtained artificially in the form of a white, infusible powder, by heating the hydroxide to redness, thus

$$2Al(OH)_3 = Al_2O_3 + 3H_2O$$

Clay

Clay consists of a mixture of *kaolin* with more or less sand and other impurities. *Kaolin*, sometimes called *kaolinite*, is a hydrated silicate of alumina, having the symbol $Al_2O_3SiO_2 . 2H_2O$. Sand is composed of grains of quartz and other minerals. Clay contains silica, both as chemically combined silica in kaolin and the other minerals, and in the free state as quartz sand. Clay also contains more or less iron oxide and smaller quantities of lime, magnesia, potash and soda.

Clay originates from the disintegration of rocks containing minerals made up largely of alumina and silica. The most abundantly occurring of these minerals are the feldspars, augite and hornblende. Decomposition takes place by the gradual leaching out of the more soluble elements of the minerals by water, leaving behind the less soluble ones, silica and alumina, together with smaller proportions of lime, magnesia, iron, potash and soda. These insoluble portions are washed over and over again and deposited in favorable places by water. Such deposits are called *sedimentary clay*, while clay which, instead of being washed away by water, is left near the rocks, from whose decomposition it was formed, is called *residual clay*.

The potter deals more particularly with the plasticity, permanence when burnt and refractoriness of clay, but to the portland cement manufacturer these properties are of very secondary importance. The main thing, of course, is the chemical composition and the state of subdivision in which the silica exists.

Editor's Note

WITH THIS INSTALLMENT the series of articles, of which it is a part, ends. The series was begun over a year ago and has covered the chemistry of materials entering into the manufacture of lime and cement, for the first time the subject has ever been treated in such a comprehensive way.

Both the author and the publisher have received many complimentary letters, and it is believed that the articles have filled a long-felt want for a scientific, yet practical, treatise on the chemistry of such basic materials as limestone, gypsum, shale, and their conversion into important manufactured products and articles of commerce.

It is our understanding that the author intends to revise and supplement these articles and subsequently publish them in book form, so that rock products producers may have a comprehensive reference and textbook on the chemistry of their materials.—The Editor.

Roughly speaking, the clay for portland cement manufacture should contain between 2.5 and 4 times as much silica as alumina. There should also not be more iron oxide than alumina in the clay, while the best proportion between these two is about one of iron to three or four of alumina. Magnesia and lime are usually present only in small quantities, the more of the latter present the better, but the former should be low (not over three or four per cent). The alkalies should not run over three per cent, as an excess is likely to cause unsound and quick-setting cement.

Iron

Iron is probably the most useful of all the metals because of the abundance of the ores in which it occurs and the simplicity of the process by which it may be prepared. All cement and lime manufacturers are familiar with the properties of the metal itself and only one of its compounds, the oxide is of interest to them in the manufacture of their product.

Iron forms two series of salts—*ferrous* salts derived from the ferrous oxide, FeO, and *ferric* salts derived from the ferric oxide, Fe_2O_3. Thus, with chlorine iron forms two chlorides, one of which, ferrous chloride, has the formula $FeCl_2$, and the other, ferric chloride, has the formula $FeCl_3$. Similarly, there are two sulphates —ferrous sulphate, $FeSO_4$, commonly called copperas or green vitriol, and ferric sulphate, $Fe_2(SO_4)_3$.

The iron in both portland cement and lime is present as ferric compounds. Ferric oxide is a red brown powder, familiar to most of us as iron rust, and the cream or brown color of lime is usually due to this constituent. The black color of cement clinker is due to the presence of calcium ferrite in the latter. Clinker in which iron is absent is white, while that containing a slight amount is bottle green.

Other Metals

Of the other metals none except manganese are present in cement, lime or plaster. Cement usually contains small amounts of manganese, but lime seldom contains anything more than a mere trace. Manganese dioxide is an intensely black substance and as much as one-tenth of one per cent of it present in the limestone will render the resulting lime appreciably dark in color.

Chromium belongs to the manganese group and with the latter is chiefly known for its steel hardening qualities. Both of these metals form acids which give rise to important salts. Chromium forms chromic acid from which the chromates and bichromates are derived. Sodium chromate, Na_2CrO_4, and bichromate, Na_2CrO_7, and the corresponding potassium chromate and bi-

chromate are extensively used in the manufacture of paint and in the tanning and textile industries. Potassium permanganate, $KMnO_4$, is an important chemical reagent.

Zinc belongs to the magnesium group and resembles it somewhat in chemical properties. Zinc oxide, ZnO, called *zinc white,* is used in paint and zinc sulphate, $ZnSO_4 . 7H_2O$, commonly called *white vitriol,* is used in medicine and for preserving timber.

Copper, mercury and silver all belong to the same family. Copper and mercury, like iron, form two series of salts. Cupric salts are from cupric oxide, CuO, and cuprous from cuprous oxide, Cu_2O. Similarly, mercurous salts are from mercurous oxide, Hg_2O, and mercuric salts from mercuric oxide, HgO. It will be noted that in all instances the *ic* salts contain more oxygen than the *ous* salts. The latter can usually be converted to the former by treating them with some reagent which will give up its oxygen to them.

Copper salts, and particularly the sulphate, $CuSO_4 . 5H_2O$, known as *blue vitriol,* are used in the preparation of blue and green pigments, for wood preserving, as an insecticide, etc. Mercuric chloride is the deadly *bichloride,* used only externally as an antiseptic, while mercurous chloride is the comparatively harmless *calomel* known to most of us as a medicine. Silver nitrate, $AgNO_3$, is known as *lunar caustic.* Most silver salts are darkened on exposure to light and hence form the basis of photography.

Lead and tin belong to the same family. Lead compounds are used chiefly in paint. *Red lead* is an oxide with the formula Pb_3O_4. Basic lead carbonate, or *white lead,* has the formula $3PbO . 2CO_2 . H_2O$. Both are used in paint. Lead acetate, or *sugar of lead,* is used in medicine, lead chromate, or *chrome yellow,* in paint. Tin forms two series of salts, stannic and stannous, from the oxides, SnO_2 and SnO, respectively. Stannic chloride, $SnCl_4$, is used in weighting silk.

Use of Lime in the Manufacture of Calcium Citrate

A GROWING USE of lime in California is in the treatment of lemon juice for the manufacture of citric acid. The lemons are peeled and crushed, the juice fermented to a certain extent, and then filtered. The entire process is described by C. P. Wilson, of the research laboratory, California Fruit Growers' Exchange, Corona, Calif., in the June issue of the "Journal of Industrial and Engineering Chemistry." Regarding the use of lime, Mr. Wilson states:

"The filtered juice is a brilliant, light amber liquid, averaging about four per cent acid. It is pumped into wooden tanks 2.4 meters in diameter by 1.5 meters high, with staves made of Oregon pine 7.6 cm. thick. Each tank is equipped with copper heating coil and mechanical agitator. A charge consists of about 3,700 liters of juice, and from a laboratory assay the amount of calcium required to precipitate the citric acid is calculated. In practice, sufficient hydrated lime of high purity is added to precipitate 90 per cent of the total acid, calculated as citric. Sufficient calcium carbonate is then added to neutralize the remaining 10 per cent of acid, and an excess of 7 kg. of calcium carbonate is added.

"Experience has shown that if the juice is completely neutralized with calcium hydroxide, dark-colored compounds are formed. These compounds are difficult, if not impossible, to wash out, and if not removed cause the liquor produced by the decomposition of the citrate to be very dark-colored. This increases the difficulty of securing satisfactory crystals.

"It has also been shown that, however great the excess of calcium carbonate added to the juice, there is always a small residual acidity, varying from 0.08 to 0.20 per cent, depending on the acidity of the original juice."

Notes on Whitewashing the Barn

Why Do Lime Manufacturers Slumber With Markets Like This Begging for Development?

BELOW is a little "story" from the *Rural New Yorker,* one of the best of farm journals. It ought to be clear from this that there is a way to get orders for lime. That way is "to go get 'em."

Will you give advice about whitewashing barns so as to keep cattle clean in winter? The men are busy these times on farms, and it is hard to get anything done. If you will give something on this subject I am sure it will do a great deal of good. A. S.

It seems like a very useless job to me, to be writing an article on the advantages of whitewashing the cow stable. Such an article seems about as necessary as one advising the spraying of the potato patch to kill the bugs. But I suppose that there are a good many farmers who have never sold market milk, and, in fact, have never given very much attention to the dairy department of the farm, who have never whitewashed their stables or even swept down the cobwebs and other dirt that naturally accumulates with the passing years. I went into the barn, this spring, of one man who produces milk and retails it in the nearby village, and found that this barn had never been whitewashed, and the dirt-laden cobwebs hung in festoons from the beams overhead. How he managed to get away with it is more than I can guess, unless he has some especial pull with the local board of health.

But the average farmer does not need a board of health to make him clean up his cow stable, any more than he does to make him wash himself or shave and get an occasional haircut. Still, I hardly believe that all who do not keep their stables in good condition are filthy in their habits, but rather that they have never got in the habit of cleaning up, and don't understand the comfort and general satisfaction one gets from working in pleasant surroundings.

*A good slick-talking agent will come along and tell one of these men about the great advantages and satisfaction he will receive from installing a lighting plant on his farm and, like as not, the man will invest several hundred dollars in such a plant, which I am not saying is an unwise thing to do. But I will say that such a lighting system installed in a dirty, unwhitewashed barn, will give no more light than two good lanterns with clean globes will in a clean barn where the overhead and side walls are gleaming with fresh whitewash.**

And then the whitewashing is such an easy and inexpensive thing to do. A bushel of lime and a peck of salt will furnish the material to whitewash a good-sized stable. Of course the salt may be left out, but it pays to put it in. The wash gives off a more glistening light, and stays on much better with the salt added. The regular government formula is probably the best to use. Slake half a barrel of lump lime with hot water. Strain and add a peck of salt dissolved in warm water; 3 lbs. of ground rice put in boiling water and boiled to a thin paste, ½ lb. of Spanish whiting and 1 lb. of glue dissolved in water. Mix and let stand for several days. Apply hot.

Of course one should use a spray pump to apply the wash. There is always one in the neighborhood that can be borrowed or hired for a small sum. Then the cost of labor is very light, for a rainy day is just as good as any for this job. Remove all the windows from the stable and then thoroughly sweep down the ceiling and sidewalls. Go over the whole thing with the wash, and after it dries go over it again and touch up the spots that got only a sprinkling the first time. Then give the windows a good cleaning and put them back.

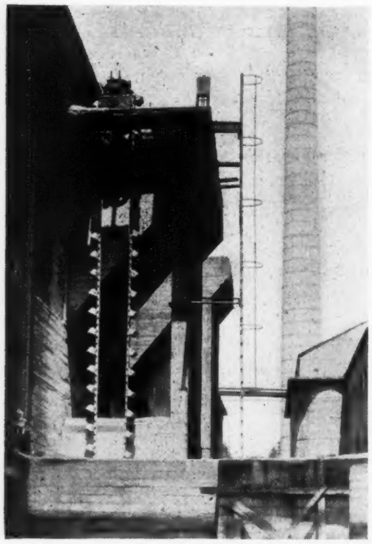
If you don't get a good thrill of satisfaction every time you step into that barn for at least a week afterwards, you had better sell the farm and hire out in a coalyard.—J. Grant Morse.

*Italics are ours—Editors, Rock Products.

Hints and Helps for Superintendents

Chain Drag Conveyor for Handling Live Clinker

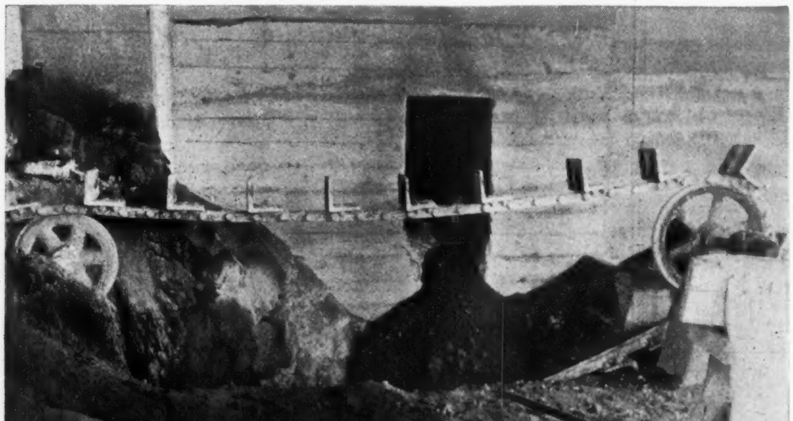
THE TWO VIEWS herewith show a type of cement clinker cooler and clinker handling arrangement developed at the plant of the Indiana Portland Cement Co., Greencastle, Ind. The cooler consists of a pit or trough and a chain drag conveyor. As the live clinker comes from the kiln it falls into this pit or trough and is then dragged to a point where it receives a light sprinkling with water. From here the chain drag conveyor continues to carry the clinker until it discharges into a bucket elevator which carries the clinker to the clinker storage building. A travelling overhead electric crane distributes the clinker in this storage and also transfers it for passage through the finish grinding mill.



Bucket elevator to clinker discharge

This arrangement for clinker handling has given the Indiana Portland Cement Co. complete satisfaction and the company has discontinued the use of rotary coolers, which they claim not only takes a whole lot more power to operate than the chain drag conveyor but also has a tendency to retard the capacity of the kilns. In addition to this the rotary cooler requires considerable space while the chain drag conveyor is so flexible that it can almost be placed at any point.

The president and general manager of the Indiana Portland Cement Co. is Adam L. Beck, a man who is well known throughout the entire cement industry.



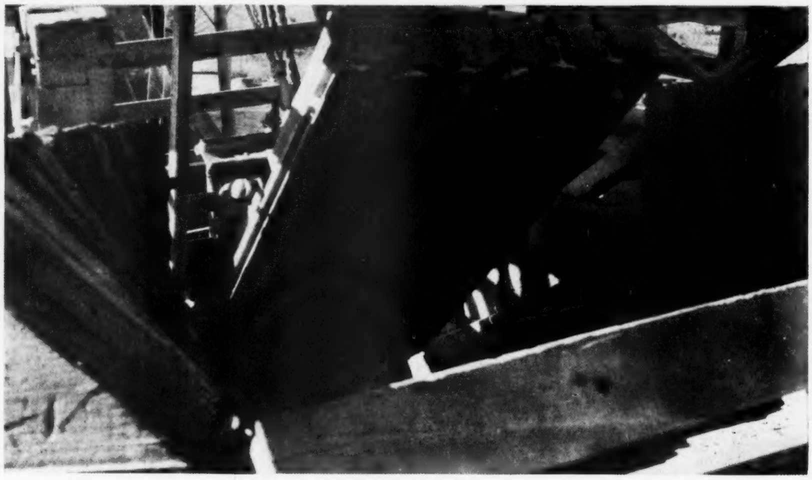
Chain drag conveyor—kiln discharge

Device for Feeding a Jaw Crusher

WILLIAM E. CARSON, president of the Riverton Lime Company, Riverton, Va., although born an Irishman and a Virginian by adoption, shows all the inventive traits of a genuine Yankee. His plant is a veritable incubator for developing original ways of doing things.

Like nearly all Southern lime plants, his quarry operation was a hand-loading proposition until the war hit us and labor became scarce and high. At the same time greater demands were made on this lime plant because it was called upon to fill large orders for chemical lime to be used in the war industries.

Mr. Carson then installed a steam shovel in his quarry and the largest jaw crusher immediately available. This crusher was a somewhat smaller size than ordinarily specified for steam-shovel rock and the usual experience of the larger pieces of rock bridging over the opening and holding up the work was the result.



Device for regulating feed to a large size jaw crusher

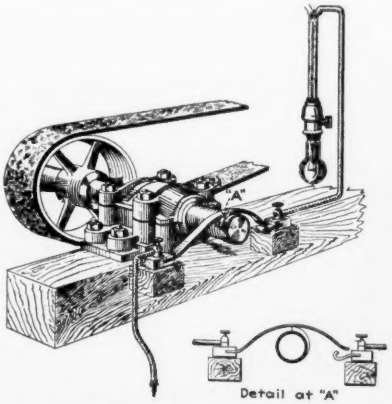
As is often the case, it was found that the pieces of rock were not too large to go through the crusher, if they were started on their trip right. So the feeder shown in the accompanying illustration was devised.

This feeder consists of a heavy apron made of steel railway rails and heavy timbers suspended over the crusher-feed chute, as shown. The lower end is carried on a chain hoist so that it can be raised or lowered, varying the width of the chute opening into the crusher.

As can be readily seen from the illustration, the action of the movable apron is to prevent the rocks rushing down and jamming over the crusher opening. Instead they are compelled to take a course that insures their smallest end entering the crusher first.

Indicator for Belt Conveyor

WHERE rock crushers feed directly upon a belt conveyor, the stoppage of the conveyor belt, unless it be known to the crusher man in time, results in considerable spillage before the feed to the crusher can be shut off. To give warning of such stoppage the device shown in the sketch is used at the mill of the Carson Hill Gold Mining Co. at Carson Hill, Cal. An electric light is suspended so as to be visible to the crusher man. In the lamp circuit is a make-and-break switch which is operated by a cam on the shaft of the drive pulley. The flickering of the light continues as long as the conveyor belt is running.—*Engineering and Mining Journal.*



Indicator for belt conveyors

[Two somewhat similar devices have been described and in Rock Products (Aug. 29) was a description of the automatic control of an entire lime plant.]

Increasing Lime-Kiln Draft

ANOTHER interesting and original practice at the Riverton Lime Co. plant, Riverton, Va., is the use of a brick stack on the hill back of the lime kilns to furnish the draft.

The kilns are operated with producer gas, with an induced draft. As originally laid out suction pipes at the top of the kilns were connected to an exhaust fan.

Mr. Carson's theory and practice of efficient lime kiln operation is draft, and plenty of it. The views show how he has got it without operating cost.

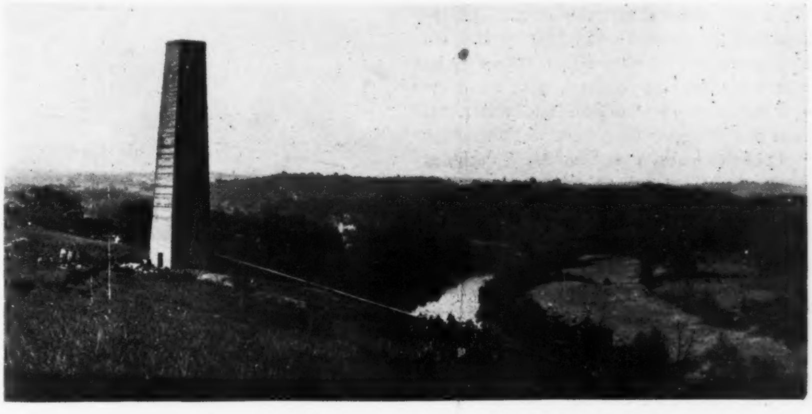
Instead of leading the draft conduits to a suction fan, he now sends them through a reinforced concrete flue up the side of the hill back of his kilns to a brick stack whose top is 185 ft. above the tops of the kilns. Mr. Carson figures this gives him a draft on the kilns equivalent to 50 to 100 h. p. expended on a fan operation.

View from top of hill overlooking crushing plant and quarry

Stack and concrete flue up the hillside from a distance

There was a trick to make the flue work that does not appear on the surface. The concrete flue receives the gases of about the same number of kilns on each side, entering the base of the flue in opposite directions. Until this flue was properly baffled to permit it, the pressure of the opposing currents of gas was neutralized and the draft was nil.

This baffle or deflector, of course, turns the gases into the flue from either side and prevents pressure of one side equalizing that from the other. The flue is not lined, as the temperatures do not require it.



Concrete and brick stack on top of hill behind the kilns

Sand Settling and Sand-Settling Devices

No. 8. Drag Belts, Flight Conveyors, Dorr Classifier and Screens

By Edmund Shaw
Allen Cone Co., El Paso, Tex.

THERE are probably more forms in this class than in any of the other classes described here, and all sorts of results can be obtained from them according to the way they are designed and run. At one end of the series is the old "Chinese pump" which is a fast running drag belt in a narrow and close-fitting trough. It is not a settler for it lifts the whole feed, including the water. But by slowing it down and putting a settling basin at the point where the feed is received, with an overflow to carry off the fines and water, we have the ordinary drag belt. At the other end of the series is the well designed flight conveyor, set at the proper angle and run at the right speed to produce a clean and fairly dry product.

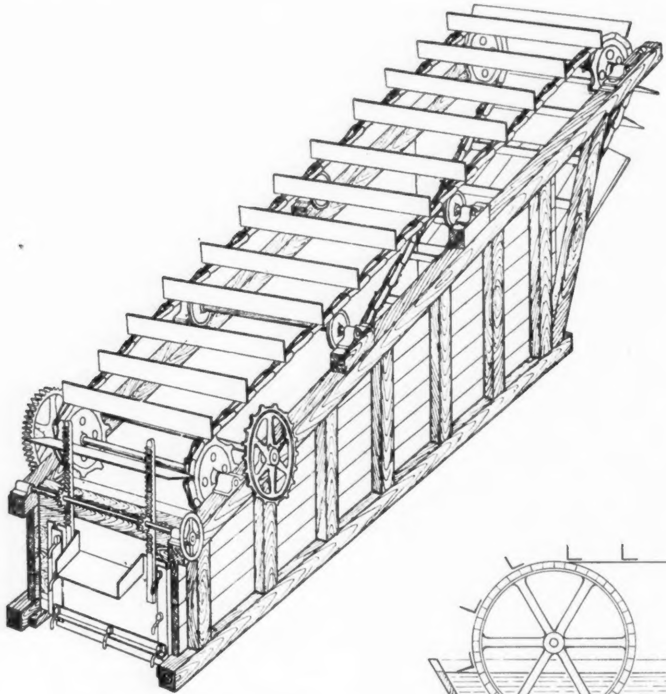


Fig. 19—Standard classifier

The tendency of the drag belt to produce too wet a product has been noticed and attempts to improve its work in this respect have been made by perforating the drags or by using "step drags." These are a little more than half the width of the belt and are placed on alternate sides, so that a zig-zag central passage is left for the water to run back to the settling part of the machine. These have not been found very successfuly and plain drags are usually preferred by the makers of such machines.

The belt type has the disadvantage of bringing out a lot of the sand on the upper side of the belt from which it must be removed by sprays or brushes before the belt strikes the head pulley. With the chain types this difficulty does not arise, but the chain has the fault common to all chain driven machinery, that wear causes the chain to lengthen so that the links do not strike the points of the sprocket wheel. In the mining field where drags are used at all, the belt type is preferred. In the rock products field, where coarser and heavier material is handled the chain type seems to have the preference.

Fig. 19 shows a flight conveyor of standard design, used in connection with a settling box, to remove the settled product.

Fig. 20 shows a drag belt formerly much used in the mining field. It will be noted that this machine is designed so that all the bearings are out of water. The drags, or flights, are pieces of angle iron put on with elevator bolts. The pulleys are of steel or cast iron and are logged with strips of wood to give a cheap wearing surface and a surface upon which the belt is not liable to slip.

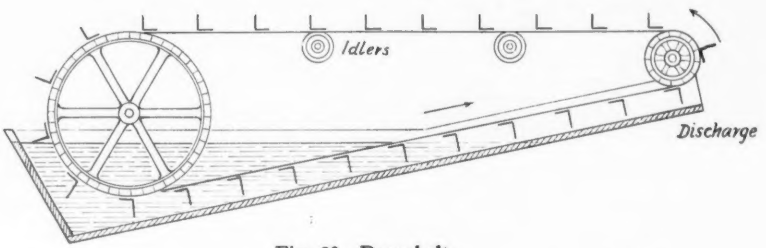


Fig. 20—Drag belt

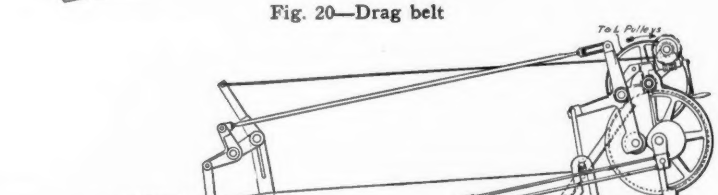


Fig. 21—Dorr classifier

Dorr Classifier

It will be noted that all the mechanical means used to remove the settled solids from a basin, in the types of machine we

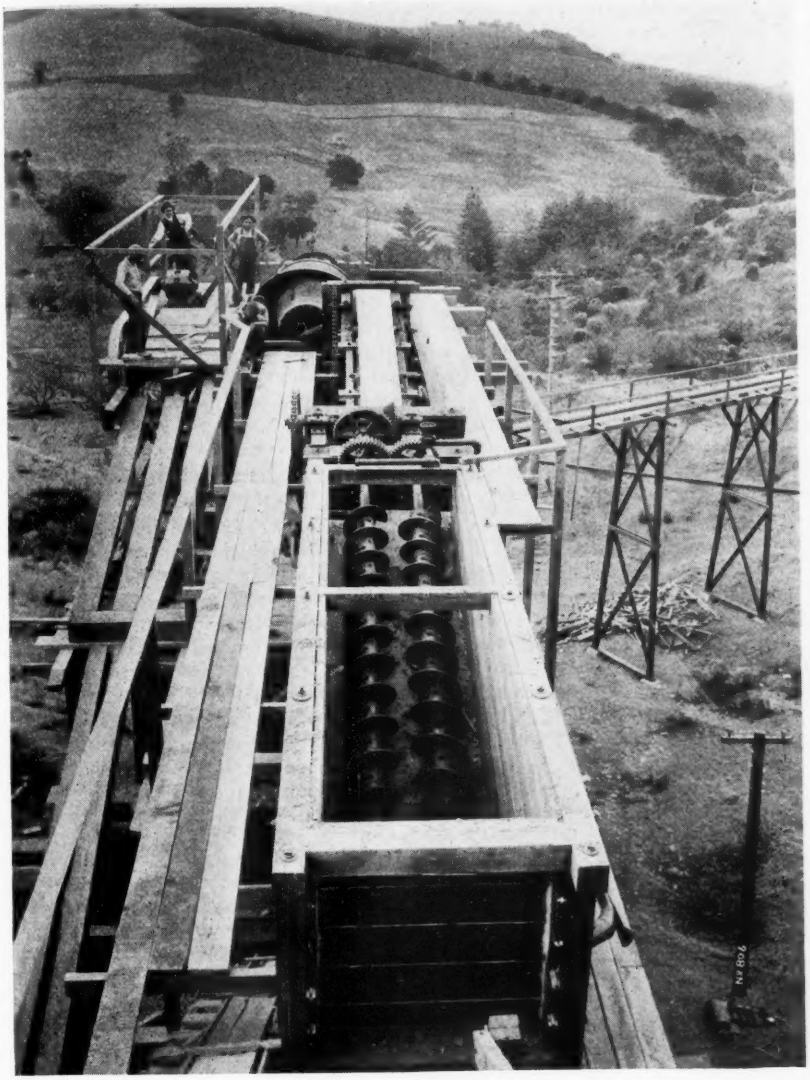


Fig. 22—Screw washer

are now considering were originally used as conveyors or elevators. There the drag belt is taken from the "Chinese pump," and the chain drag from a type of conveyor in use in many industries. The sand screw is the screen conveyor and the sand wheel is an old elevating device, used in Egypt for thousands of years.

The Dorr classifier (Fig. 21) makes use of a conveying device not so old or so well known as these, but which has been employed for a long time in mining and other industries. In its older form it is known as the "ladder conveyor." This consists of a series of blades or scrapers which have a forward and back motion. On the forward stroke the scrapers are down on the bottom of the trough in which the material is carried and draw the material with them. On the return stroke the scrapers are lifted up and over the material and then dropped to catch a fresh hold before drawing the material forward.

This has proven a very satisfactory method of drawing out the settled material from a settling basin. The progress of the material is by a series of hitches and half the time it is standing still, which gives a chance for the water and fines to drain back to the settling basin. As the scrapers are lifted above the discharge apron during drainage they do not interfere with the flow. For this reason the Dorr machine gives a dryer and cleaner product than that usually produced by drag belts.

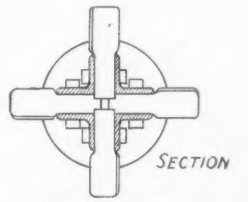
The Dorr machine has met with great success in the mining field especially in connection with ball mill and tube mill grinding. It is used in closed circuit with these machines to discharge whatever material has been sufficiently ground and to return the remainder to the mill for further grinding.

Screws

From the historical point of view, the Archimedian screw is probably the first mechanism used to withdraw sands from a settling basin, and it is natural that a great many forms should have been invented and patented. The simple sand screw, or screw washer, consisting of a basin to receive the feed, an overflow and a screw to remove the settled sand is still the best known and most widely used machine of this type. For materials that tend to stick and clog the machine a "ribbon" type of screw has been designed. This has a ribbon wound about a shaft to form the screw thread, but the ribbon is held away from the shaft a certain distance to give a clear space at the point where packing and sticking usually begins. The makers say that the capacity of a ribbon screw is practically the same as the form with a solid thread.

The Akins classifier employs a ribbon screw of very large diameter and interrupts the screw thread to give a chance for drainage. The Avoca classifier has two channels outside the trough in which the screw works with occasional openings to allow the water to flow into these channels and down to the settling basin. Another form, known as the Colbarth, uses two screws set side by side but turning in opposite directions (Fig. 22). This arrangement was made to break up the packing which was sometimes found to occur when the single screw was used in fine sand. This fine sand would accumulate until it formed a tube in which the screw would run without lifting anything.

A screw composed of paddles or blades not only urges the material forward but cuts the mass and mixes it thoroughly. A screw of this kind is known as a log



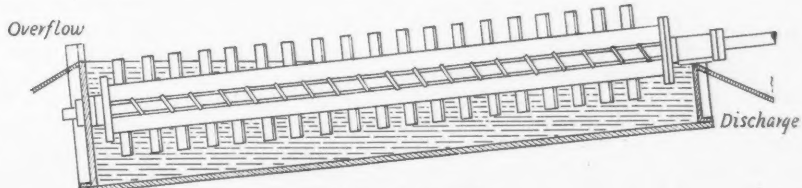


Fig. 23—Log washer

washer. The name comes from the fact that the central shaft was originally the trunk of a tree into which the blades were driven in spiral form. This old-fashioned affair is still in use as a washer in some out-of-the-way places, but has generally been succeeded by a "log" built up of steel bars to which the plates are attached.

Although the cleansing function of this machine is usually thought of first, it is none the less a settler and does not differ from the sand screw except in the design and proportion of its parts. It has a settling basin, an overflow and a discharge of settled solids and makes a separation of fine and coarse material in accordance with the laws of settling.

Fig. 23 shows a log washer. As the section shows, the "log" is built up of four angle irons. The blades are inserted between these angle irons and fastened by bolts. Two logs are almost always run in the same trough and they are sometimes set so that the blades on one log pass between the blades on the other log. The idea is to cut and turn the settled material as much as possible, cut clay balls to pieces and cleanse material by attrition.

Log washers are the standard washing machine in the Florida phosphate fields and are also used, along with the washing can, previously described, in the Tennessee phosphate field. They are very largely used for for washing iron ore.

In this and the other sketches shown no attempt has been made to give working drawings or to preserve the proportions of the machine. The sketches are more in the nature of diagrams as they are only intended to bring out the principles by which the machine works.

(To be continued)

A Stitch in Time

Associated General Contractors to Fight Priorities Unfavorable to Construction

THE following letters sent to the presidents of associations interested in construction and to the Interstate Commerce Commission August 17 by R. C. Marshall, Jr., general manager of the A. G. C., are self-explanatory:

To Other Construction Associations

"The disruption of construction in 1920 caused by the Interstate Commerce Commission's priority orders and the consequent losses to material manufacturers and contractors are not yet definitely removed as a possibility in this year's work. An opinion is expressed by both the Geological Survey and the American Railroad Association that a shortage of open-top cars is liable to result from any sudden revival in industry.

"Last year's disaster, which we all know would happen if priority orders were adopted, did happen and will doubtless happen again should priorities be reinstituted. Therefore, in order to provide against this contingency, it is essential that no priorities shall be established without due regard for the right of each industry involved.

"Having stated this matter to the commission in the attached letter, we should like to ask your co-operation in avoiding a recurrence of last year's losses. We suggest that you address the commission along similar lines, and point out the injury to your own industry which resulted from priority orders.

"In order that this question may be presented before any shortage occurs, may we have copies of any letters which you write to the commission and any suggestions to the plan as soon as possible?

To the Interstate Commerce Commission

"Reference to a possible car shortage made in June by Mr. Clark, former chairman of the Interstate Commerce Commission, mentioned the difficulties which arose from a general disinclination to purchase coal during the summer of 1920, and also called attention to a similar attitude this year.

"Before the Interstate Commerce Commission again exercises its authority to allocate cars for preferential shipment of a particular commodity, in the event of another car shortage, we desire to call the commission's attention to the unnecessary losses such action placed upon the construction industry in 1920, and to advise the commission that re-establishment of such orders can justly evoke from the construction industry only vigorous protest. Should industrial consumers and dealers cause a shortage of open-top cars in September or October by refusing to purchase coal when the carriers are able to serve them, their belated demands for open-top car transportation can not in justice be filled by disrupting other industry.

Millions Lost by Construction

"For want of a relatively small number of cars wherein to ship materials in 1920, construction companies lost many millions of dollars. They were bound to both private and governmental agencies by rigid contracts which penalized them for delayed completion; and yet through governmental agencies, their markets were upset and their work was indefinitely delayed. The service orders of the commission thus forced either the abrogation of contracts or the assumption of financial loss. As construction is especially dependent upon frequent deliveries of material and uses little storage, it was without doubt more severely disorganized than any other major industry.

"When open-top cars were assigned almost exclusively to coal shipments, a drastic discrimination against needed construction was established. Except in the case of isolated permits, no relief was obtainable, and no recourse was afforded from either contractual obligations with the government or from resulting financial loss. With their elaborate organizations in the field waiting expectantly for materials, construction companies were obliged to witness great numbers of cars either in transit to the mines empty, or in transit to terminals where they were accumulated or reconsigned. Those cars at the lake ports whose cargoes of coal did not move to the Northwest for weeks, thus facilitating price manipulations, would have averted a great portion of the losses, had they been available to the construction industry.

Shortage Must Be Shared

"It is obviously inequitable, even in anticipation of emergency, to deny public utilities service to certain essential industries and thereby permit another to misuse these facilities for undue profit. When such regulatory action is imperative it should not disproportionately interfere with construction work, but should require each industry to assume its share of the burden. When a governmental agency is authorized to take such action, we feel it is in justice bound to provide sufficient administration to carry out its intention. Had such administration been provided the commission could doubtless have saved the public significant loss in 1920.

"Financial considerations, however, are not the only factor to be considered. The country is still short of housing facilities and unemployment is widespread. Since construction, especially dwelling and public works, is one of the few industries now actively contributing to overcome both of these conditions, this industry should be among the last affected by regulatory action. Any interference with the shipment of construction materials (during the next three months) will result not only in financial loss, but also in a serious increase of unemployment. Should some form of service orders become unavailable, it is essential that the commission take cognizance of these facts."—The Bulletin of the A. G. C.

Production of Mineral Granules

Discussion of a New Phase of the Rock-Crushing Industry

By H. A. Megraw
Engineer, Kennedy-Van Saun Manufacturing and Engineering Corporation, New York City

THE MANUFACTURE of rock granules has become a very important factor in the rock-products industry, and one that is of great interest to all rock producers. It has been found that many operators can find a market for a portion of their product which has either been treated as waste, bringing no income, or else added to other products to which it is not essential or, perhaps, an actual detriment. In such cases, where the character of the rock is suitable, a material increase in the average per-ton receipts may be secured by proper separation and treatment of the fine, granular part of the output.

Rock granules are used for various purposes, the principal of which are slate (or other colored rock) for use in the manufacture of prepared roofing, and quartz, limestone, marble, granite or other suitable rock granules for the preparation of terrazzo. These industries require the production of granules or particles of rock varying in size from about ⅜ in. cubes to 16-mesh product, the latter being material that will just pass a square mesh wire screen having 16 openings to the linear inch, but will not pass one with 20 openings. The requirements in individual cases will differ, depending upon the standards of the manufacturers using the material, but in any case the principles governing its production will be the same.

Character of Materials

In considering the production of granules, careful consideration should be given to the character of the material to be crushed. This will vary all the way from soft grades of slate to quartz, a very hard and abrasive mineral. The action of each of these under different crushing machines will be very different, both in character and in degree, but the tendency of each type of machine is likely to be toward the same or a similar result. That is to say, that under direct compression crushing a soft slate will tend to be broken up into an excessive number of exceedingly small pieces, while a tough, granitic rock would, while producing some fines, tend to the production of pieces of much greater size.

In a great many rock-producing plants there is a specific use for all of the output. It is usually screen-classified and the various size products sold to those demanding them. In plants built and primarily designed for the production of rock granules it is seldom true that there is any commercial use for any material other than that for which the plant is specifically intended. Consequently the desideratum is an installation in which the greatest possible percentage of the rock is turned into the product sought for.

Ordinarily, in such installations, there is very little difficulty in reducing to the desired size, but there is very serious difficulty in stopping at the right point. Of course there are no crushing processes in which some proportion of undersize, or fines, is not made, but there are means of limiting the percentage fines that do not seem to be widely understood. Consequently the greater part of this discussion must be on the principal problem—that of minimizing the percentage of waste, the undersirable fines or dust, which is not useful for the purposes for which the plant has been installed.

Stages of Reduction

The stages of rock reduction may be divided into breaking, crushing and grinding. The breaking stage comprises the first or primary stage, taking the product from mine, quarry or pit and so reducing it in size as to make it suitable for further reduction in the secondary or crushing machines. The secondary crushing operation may be accomplished in one step or in two or more stages, depending upon the character of the material. The third stage comprises, pulverization, which for the purposes of this discussion, may be omitted, since it does not form a factor in granule production, although it may serve in the making of an auxiliary product.

Primary Breaking

Primary breaking is usually performed in one of two types of machines, and since these are probably the best ways to do it, the advantages of each will be considered. The two types of primary breaking machines are the Blake jaw-type and the gyratory type. Each has its special field, and the conditions under which either should be used are definite and clear cut.

The governing factor of primary-crusher service is the relation between the maximum size of the rock to be handled and the ton-capacity required per unit of time. This is the case because of the fact that jaw type crushers have a larger feed opening per unit of weight than have crushers of the gyratory type. Consequently for small tonnage output with ability to take large pieces of rock, the jaw crusher is indicated. Conversely, when larger tonnages are required with medium opening size, the gyratory is preferable. The gyratory crusher has much greater capacity per unit of weight (and consequently of first cost) than has the jaw crusher, and its capacity per horse power is also considerably greater, so that where its capacity can be utilized, it is the most economical machine to use.

Up to this point the discussion of the two types of primary breakers has been based on economic principles. But the technical aspects of the two machines or types, have also to be considered, since the production of the desired material may be much altered by the selection of one type as considered against the other. The object of the crushing operation now under consideration is to produce granules of the required size with a minimum production of material under that size. The question, then is—how do these two crusher types compare as producers of fines or dust?

Considering the Blake-type jaw crusher, we find that consists of two plane surfaces inclined toward each other, one of these surfaces being hinged at the top and movable at the bottom. The bottom of this plane moves reciprocallly back and forward, the stone entering between the planes while open, and receiving the crushing force as the opening is reduced in size, due to the advance of the movable jaw. Thus the stone is broken by a direct-compression force, tending to crush and grind the stone into fine pieces. The interface movement of the pieces into which the stone is fractured tends further to produce a very finely ground powder.

An additional factor is the action of the rock between the plane surfaces of the crusher jaws. Since jaw crushers are made with a rather wide angle, and since the closing of the jaws increases this angle, there is a tendency for the stone to slip, particularly when the stone is of such size that it approaches the limit of the nip angle. In practice there is a great deal of slip of the stone between the jaw faces, in fact, it has been shown that most of the wear on jaw crusher plates is caused by this slip. And this grinding also tends to produce an undesired amount of finely powdered material.

The gyratory machine breaks the stone between two curved faces, the concaves and the head. Consequently there is a chance for pieces of stone to be supported at the ends and unsupported in the middle, as a beam and the break accomplished cleanly and with a minimum of undersize. Again the movement of the head is continuous, not

intermittent, and strikes the stone a blow, as with a hammer. The effect, in general is to break more cleanly, make a more cube-shaped product and to produce less dust than is the case with the machines of the jaw type. A study of the diagrams shown in Figs. 1, 2 and 3 will illustrate the points brought out.

Secondary Crushing

No single machine is capable of reducing stone from the size at which it comes from the quarry to granule size at one operation. If such a machine were available, it would not be suitable for use in such work, because of the inordinate amount of fines or undersize that would be made by it. In general, the greater the reduction ratios in one machine, the greater the amount of fines produced. This is due to the crushing or grinding of the interfaces formed at the first rupture. In order to minimize the formation of fines, therefore

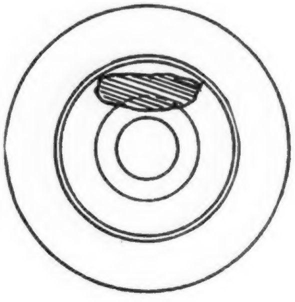


Fig. 1

the reduction ratio should be limited as much as possible. It would be better to limit the size reduction to a ratio of 1:2 if it could be done, but commercial considerations make it necessary to go as far as 1:3 or 1:4. The exact point to which the reduction can be carried depends a good deal on the kind of machines used for the operation. Consequently the available types ought to be discussed.

There are three types of secondary crushing machines that may be used to take stone from the primary crusher and reduce it further in size. Two of these, the gyratory and jaw types, have already been discussed, so that their characteristics do not require any further discussion. The third type, crushing rolls, still has to be considered.

Essentially the crushing roll consists of a pair of equal sized cylinders revolving toward each other. These cylinders are set at a distance from each other equal to the size of the desired product. Since the angle of nip must be varied in accordance with the size of piece to be crushed, it follows that the larger the piece fed to the roll, the larger must be the diameter of the roll cylinder. If R = radius of the roll cylinder, B = the friction angle (16° 45′); coefficient of friction = 3, and the size of piece that will be nipped = x, then

$$x = Cos\ B = \frac{R\text{-}K}{R}$$

The crushing roll accomplishes its work by compressing the piece between the two revolving cylinders. If the ratio of reduction, or alteration of size, is very small, the piece receives a light nip and is efficiently reduced with a very small percentage of undersize. Thus a 1-in. piece fed through a roll crusher set at ¾-in. would perform good service. When the ratio of reduction is great, however, the

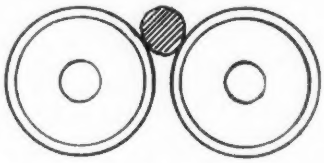


Fig. 2

initial break is followed by an increasing sequence of crushings and grindings, resulting in attrition of the interfaces and an abnormal production of fines.

Where it is possible to use a large number of very small reduction stages, rolls may be used with fairly good results, but actually this is never done, since it entails an installation expense far too great to be undertaken. The use of rolls, then, making rather large reduction stages, inevitably leads to the production of a large percentage of fine undersizes, or waste, from which no income is available.

As a matter of fact, rolls are very widely used in the production of mineral granules, principally because the theory of roll crushing appeals to operators who do not recognize the effect of direct compression nor realize the inevitable result of interface attrition. When a full realization of this effect is reached, operators will cease trying to reduce rock in rolls, where it is necessary to minimize the production of fines.

The Short Tube Mill

There is another method by means of which granules may be produced with a minimum of fines and that is the use of a very short ball tube mill. But the engineer who suggests this method to operators accustomed only to the standard practice of using rolls, is in for an uncomfortable experience. He will be told that a machine widely used for the fine pulverization of mineral substances would be an absurdity where fines must be avoided. However, the suggestion is not absurd in any way. The average operator simply is not posted on the characteristics of the ball tube mill. It ought to be recognized that this machine is the most flexible device known for the reduction of rock or ore to any desired point. To produce any fineness of particle size, it is necessary only to modify the relative dimensions of the tube, and its manner of operation.

The ball tube mill is well known to engineers familiar with mining and cement making. It is simply a cylinder with hollow trunnions to provide for entry and egress of the material, lined with chilled iron or steel and provided with steel balls to perform the crushing. The cylinder is revolved at a rate or speed sufficient to carry the balls, by centrifugal force, to the upper part of the cylinder, allowing them to drop freely upon the material to be crushed. Thus, the reduction is performed by impact, and there is no interface attrition.

In tube mills it is evident that the longer the tube, the greater will be the number of blows applied to the material being reduced and, conversely the shorter the tube, the fewer the blows administered. So that if, for example, we put into a tube material in size from ½-to 1 in., give it a blow with a ball properly adjusted in weight, we will produce a number of say, ¼-in. pieces with very little dust. But we must avoid striking these ½-in. pieces again, if

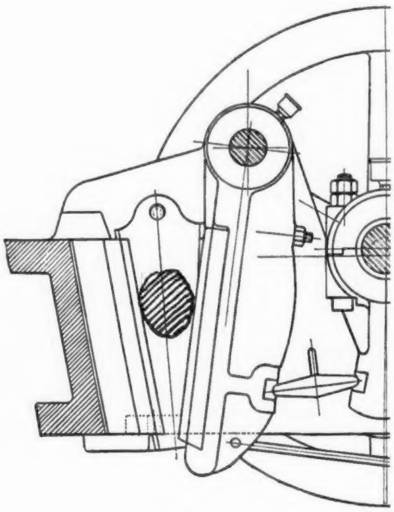


Fig. 3

this is the size we want, so that the mill must be short enough to allow them to be discharged before they have a chance to be struck again. Also, the ball must be so proportioned that it will be just heavy enough to break the piece of rock without pulverizing it, which it will do if the ball is too heavy. The feed to the mill should be forced, thus making the material pass through rapidly, assisting in preventing more blows than the material ought to receive.

It is, then, only necessary to provide a tube of proper diameter, balls of proper weight and drop, and a very short tube, perhaps only two or three feet long. The material is fed through the tube rapidly, screened after its exit, and the oversize returned to receive another blow. In this

way an absolute minimum of fines is produced.

While the writer has no knowledge of this system having been applied to production of mineral granules, he does know of its application in a special form of metallurgy where a granular product was required, and it proved decidedly successful. There is little doubt that it would prove a great saver of material in the granule-producing industry.

Principles of Plant Design

Having reviewed the available machinery types for the purpose of producing mineral granules, there remains for discussion the general principles of plant design, the object being to arrive at the selection of the most available machines and their arrangement so as to secure the most nearly ideal results.

In general, the first principle should be that each crushing machine be followed by a screening machine in order to remove whatever undersize is formed, separate whatever quantity of granules is made, and to deliver a clean oversize to the succeeding machine.

Sometimes it is necessary to dry the stone, but this should be done, not on coarse material, but on the stone that has passed one or two crushing stages. The reason for this is, of course, that the finer stone has a much greater exposed surface and consequently is easier and cheaper to dry.

Crushing should be performed in as many stages as is commercially practicable, since small reduction ratios tend toward the production of a minimum of fines. And it is equally essential that each stage of crushing should be followed by a screening operation to remove all the particles small enough to be used, preventing their further reduction, the effect of which would be to convert a salable material into unsalable waste.

In outlining a plant of this kind the crushing units should be selected with a clear view of their characteristics, selecting wherever possible these crushing by beam action or impact, and avoiding direct compression devices or those employing any form of attrition. It is best to stick to the gyratory principle as far as possible in all crushing stages, with liberal use of screens.

The average plant should begin with a primary gyratory crusher having an opening sufficiently large to receive the average piece of rock coming from the quarry. It is not essential to have this crusher large enough to take the largest rock that may occur, since that would involve unnecessary expense, but it should have sufficient opening to the largest pieces that come continuously, and in large percentage, since if the machine were smaller it would involve continuous expense for the hand labor of sledging. The proper balance of the size of this primary machine against the size of the rock to be handled is a point requiring careful consideration, but the study necessary for a proper selection will pay good dividends in success for economical plant operation.

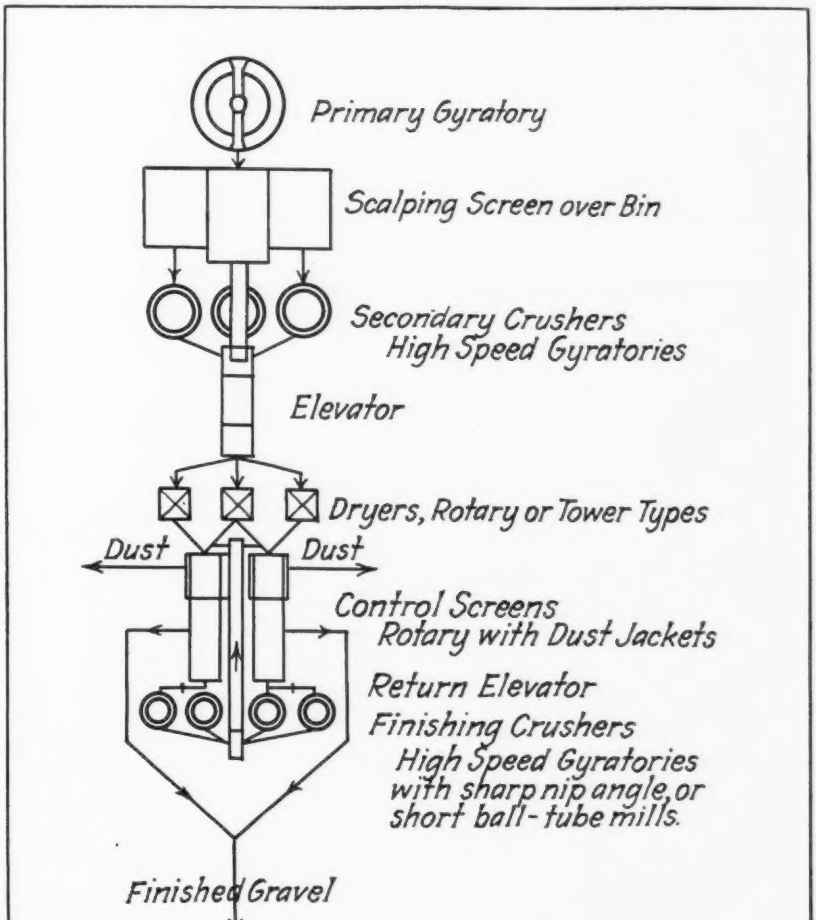
If the primary crusher is of considerable size, say a 10-in. wide opening or larger, it will not be essential to screen before proceeding to the second crusher, although a rough scalping screen may be beneficial. The first crushing stage should not reduce the rock to less than 3-in. maximum size, a size approximate for secondary crushing.

The second stage should be a smaller gyratory with a specially sharp nip angle, taking the rock to about one inch maximum. At this point, the drying, if drying is to be part of the operation, should be performed. A plain rotary-tube dryer may be employed, or one of the gravity-tower type, depending a good deal on the amount of moisture to be removed.

From the dryers the material is fed to the control screens. These screens should be of the rotary type, of ample size to perform the required classification and make clean products. They should be equipped with wire-cloth dust jackets in order to take out all of the undersize that may be in the material. These screens are ordinarily placed over bins so that the products made may fall by gravity into their proper divisions in the bin.

The oversize from the control screens should proceed to the next crushing stage. The machines employed for this duty should be the final ones, and may be either small, high-speed gyratories with very sharp nip angle, or very short ball-tube mills. The product of these machines, whatever they may be, is elevated and returned to the control screens. This forms a closed circuit from which no product can emerge until it is sufficiently reduced in size to pass through one of the openings of the control screen.

The accompanying diagram shows graphically the passage of the material through the various stages. This scheme might be made more nearly to approach the ideal by introducing a scalping screen directly after the dryers, taking out all stone over ⅝-in. in size, and passing it through an addi-



Typical flow sheet for material

tional high speed gyratory. The screen undersize should bypass this crusher, joining its product at the foot of the elevator leading to the control screens. This intermediate step is not an essential one, certainly not in all cases, but if the plant is large enough to justify the installation expense, it is worth while adding as an additional insurance against the production of fines.

The best type of screens to use in a plant of this kind is subject to some discussion. In the case of the scalping screens, there is no question at all, for the rotary machines are simpler, easier to operate and involve a very low maintenance cost. The finer screens may conceivably be of the shaker or vibrating type, but the rotary screens are altogether satisfactory if they are designed ample in size for their duty. The principal consideration is to avoid blinding, which reduces the capacity and efficiency of a screening machine. Selecting a machine that will avoid this fault requires careful study and independent judgment.

There are, of course, a number of other details that require attention in the design of a granule producing plant, but most of them depend upon local conditions such as topography, labor supply, power supply, etc. As to topography, a plant built on an appropriate incline will involve a lower installation cost than one built on a flat site, the latter calling for more elevation of material. Details of this sort require a special kind of experience and had better be left to a competent engineer.

Blasting with Liquid Air

LIQUID AIR IS BEING SUCCESSFULLY employed in blasting operations of all kinds in Germany and its cost is less than one-third that of ordinary explosives per ton of rock or shale moved. It appears that the air is compressed and liquified at the site and that compressors for the purpose have been installed at several plants. While resorting to liquid air as a blasting agent seems to have been a war-time expedient, the change to peace conditions has made its use even more economical than during the war—that is, the comparative cost has changed, but in favor of the liquid air. In discussing its adaptability to different operations, Dr. Sepsius writes for *Tonindustrie Zeitung:*

"I began six years ago to use liquid air as a blasting material and have used it in many quarries and in stones of the most varying degree of hardness. I am familiar with the diculties of its use, the loading of drill holes on high faces and particularly when one needs to be lowered to the holes by means of a rope, but in spite of these difficulties it was always possible to use it with good results. The difficulties are never insurmountable.

"Although during the war the use of liquid air showed great progress, it was handicapped by the fact that detonators were made of inferior substitutes that could not come up to all requirements. Containers made of glass, china and metal were in use. Glass was more breakable than the porcelain, but was used nevertheless, since metal was not available in sufficient quantities nor sufficiently pure. Now that the shortage of metal has stopped, glass and porcelain containers, aside from existing stock, have been entirely discontinued. On the other hand, metal containers have been greatly improved by the use of pure metal. One can now figure on excellent durability of the vacuum and consequently less evaporation of the liquid air. Those containers as well as the cartridges and detonators are manufactured by the "Sprengluft-Gesellshaft" of Berlin, who have succeeded in keeping all processes and patents in their hands as well as collecting all information on the subject.

"As far as the economy is concerned in comparison to solid explosives, I am reliably informed that under identical conditions solid explosives cost 1.54 marks per ton of coal produced in a Silesian mine as compared with .47 marks for liquid air. It can be economically employed in quarry and similar operations by use of the improved cartridges.

Selling Color

Demand for Permanently Colored Gravel or "Aggregate"

By Kirby Thomas

Consulting Engineer, New York City

THE MODERN BUILDING methods, using concrete, stucco and special roofing material, have created a new demand in the mineral field. Formerly, it was practicable with respect to most houses and structures to secure the desired color effect by the use of paint or by the selection of colored building stone, brick, tile or terra cotta. Stucco walls and composition roofing, now so generally used, are dull and unpleasant to behold, even though sometimes tinted or colored with dyes mixed with the original material, or coated with varihued calcimine. The architects have ingeniously risen to the occasion and have devised a method of injecting into the surface of the stucco and the roofing suitable and permanent colored gravel, or "aggregate," to use the trade name. In this way, not only is the desired color effect secured and the walls and roofs beautified, but a surface finishing is provided, which is most enduring.

Slate "aggregate" is often used and there are several companies in the eastern states which make a special business of grinding slate and sorting it to the desired uniform size. One company produces an exclusive permanent green slate "aggregate," much desired for some roofing purposes. Another company makes a specialty of a purple blue slate product. A plant in northern New York by careful selection is able to offer a pink and a green feldspar "aggregate," which commands very fine prices, because of the special color. In Virginia, there is a company engaged in making "aggregate" out of a glassy apple green rock, known to the mineralogists as epidote. This finds a very wide market on account of the peculiar color and color effect. A slag pile, long accumulated at one of the iron furnaces in Connecticut, provides in small amounts by careful sorting a green and a blue glass, which used as a facing certainly gives very showy results. Several plants are engaged in grinding the waste mica product to produce silvery white flakes, which are suitable for some roofing requirements, and which, when applied to bare stucco walls, makes a very "Christmasy" effect. All of these materials are of good use for the special purposes to which they are applied. The value of any particular material is, however, in its color chiefly, and so as a result there are quite a large number of secondary industries whose existence is based upon the demand for color, under the conditions of present day building.

Kinds of Limestone

LIMESTONE, according to the North Carolina Geographical Survey, is classified as follows:

Shell limestone—composed of shells, more or less reduced to fragments.

Fossiliferous limestone—in which fossil shells or other animal remains, such as bones and sharks' teeth, are prominent.

Crystalline limestone—in which the lime carbonate has accumulated largely by crystal growth around original crystalline particles in the shell fragments, or by recrystallization through the action of water and pressure. In this variety, the original character of the sediment is largely preserved.

Compact, dense, fine-grained limestone—formed of finely ground particles or from minute shells consolidated into firm rock.

Chalk—partly consolidated limestone formed essentially of microscopic shells.

Cherty or flinty limestone—containing lumps or short veins or lenses of dense silica, known as chert or flint, which result from segregation of microscopic shells or sponge spicules or silica.

Recent Advances in Plaster Manufacture

"Plastic Gypsum Finish"

By Thomas W. Cappon
Consulting Chemist, Denver, Colo.

AT A RECENT MEETING of the American Chemical Society, Dr. Alsberg, head of the United States Bureau of Chemistry, Washington, D. C., complained that there was too much tacit agreement at the meetings, too many important papers were allowed to pass without discussion, and pointed to the practice of other societies where full and frank discussion was the rule.

No doubt the head of the Bureau of Chemistry is in a position to speak with authority on this subject, having to pass on so many processes—good, bad and indifferent—that come before a trusting public. The "fierce light that beats upon a throne" can be but a twilight glow to that upon the bureau chief charged with the enforcement of the "Food and Drugs Act." At any rate the editor of the society's journal, "Industrial and Engineering Chemistry," entirely agreed with the learned doctor that more discussion of papers and processes was greatly to be desired.

It is true, old theories—or new ones—may be unsound, and demonstrably so, but they have a way of surviving; the reasonings founded on them may be dubious, yet they often pass current for long periods. Struggling industries may be handicapped, but it is easy to understand why chemists are diffident about criticising the ideas presented, for though some are quite content to have their work, if it is good work, commented on, others again rather resent this, and so the chemist who has something to say, or thinks he has, in the way of criticism, decides to "let George do it!" While "George," who has his own way to make, has already concluded it is none of his business.

Plastic Gypsum Plaster

Amongst the recent papers published in the society's journal and not commented on was one by Warren Emley describing a new form of "plastic gypsum plaster." So far as the present writer is aware there has been no published discussion of the process, and as it closely concerns both the lime and gypsum interests, it was thought that a review of the paper, and some discussion of its principal features might be of interest to the readers of ROCK PRODUCTS, which, by the way, contained a reprint of the paper in its issue of May 7.

It is needless to refer to Mr. Emley's good work in lime and gypsum, and in the present instance, both those who developed the process and the enterprising concern which promptly marketed the product, are to be congratulated on having given something like a new departure in an ancient art. Whether it will come up to expectation and "revolutionize" that art, as suggested, may perhaps be questioned.

The aim of the present process seems to have been the formation of a ready-made plaster "finish" entirely without lime, which has hitherto been found necessary to insure the proper degree of plasticity and sand carrying power, and this plasticity, it is said, has now been attained by very fine grinding, under special conditions, as in a closed ball mill.

This fine grinding was tried, and the result seems to have been somewhat of a surprise to the operators. "No satisfactory explanation," it is said, "has been evolved to date, but the fact remains the product is plastic."

What's to hinder it? remarked the Irishman of the wonder at Niagara. Such a result is, on general principles, rather what one would expect; from coarse to fine "plaster" there is a steady gain in working quality, and it is natural to suppose the effect would be progressive, could be extended, and that such was the belief of the experimenters also, prior to any experiment, seems clear from the following statement:

"The first thought was that plasticity was in some way dependent on the degree of fineness, and that fine grinding might solve the problem. Fine grinding in itself is not new in the industry, and it seems strange that any increase in plasticity due to it could have passed unobserved."

Result of Fine Grinding Long Known

If it is of any interest to note it, I may mention that it did not pass unobserved. It was noted, and as it seemed to the writer at the time, sufficiently commented on, for, in an article entitled "Problems of Plaster" (ROCK PRODUCTS, February 27, 1920), and dealing specifically with "fine grinding" and its effects, the present writer mentioned "better working quality" as one of these effects, referring to it as follows: "Generally speaking, a finely ground plaster is stronger, will carry more sand, and *work better* [in other words be more plastic] than a coarsely ground one."

Better working quality under the trowel and "plastic" quality are, it is hardly necessary to say, but different words describing the same thing. In this connection it is interesting to notice that the other effects mentioned in the article as resulting from fine grinding, as greater sand carrying capacity, greater tensile strength, as well as high cost of production, appear to have been all confirmed by the Washington tests.

After describing some curious and not generally known results that may be got by grinding finer *after*, as compared with grinding before calcination, the article goes on to point out the scope and limits of the process as follows: "But there is in practice a limit to the good results to be got in this way—a limit beyond which it does not pay to grind—as the mill's output is thereby lessened, and the cost of production increased."

Grinding Beyond Economical Limit

The investigators came up against this difficulty also, are quite frank about it, but claim it is more than offset by the advantage of having ready-made "Finish" to work with. I do not wish to question that. In that lies the whole crux of the matter, and time and practical experience will settle it. But looking back, the present writer has in this connection, recollections of an engine exhaust pounding like a field gun, bearings heating, belts slipping on their pulleys, as the Buhrs were screwed closer for the finer grades of plaster turned out; a state of things that sometimes brought about a "crisis" between millman and engineer, giving rise to fervent anticipations amongst the rest of the hands, and yielding in point of general interest only to the late Dempsey-Carpentier affair.

While discussing this question of *plasticity* and fineness, of which it is said "no satisfactory explanation has been evolved," one feels tempted to speculate on the physics and chemistry thereof and explain it as mainly due to the superior *mobility* of fine plaster particles over large ones, in a liquid medium, enabling them to slide

more easily on each other, and spread better under the trowel; this seems to be the predominant factor, otherwise fine grinding would not produce the effects it does. While, in its chemical aspects, the greater strength, sand carrying power, and water absorption of such fine plaster seems directly due to the fact that there is less inactive material present. In other words, more of the solid is brought within the sphere of action of the reacting substances (water - plaster). In fact the phenomenon seems to suggest something analogous to what is known as *mass action*, in *chemistry*.

A more familiar illustration, for the lime manufacturer, might be found in the case of a lump of underburned quicklime, where we have a "core" of unchanged carbonate in the center of a lump of highly active chemical substance. Such "core" has been out of the sphere of action of the fire, and has remained unchanged, useless, inert, and takes no part in any subsequent slaking or cementing operations.

To come, however, to other interesting features of the recent paper. It was soon observed that another sort of limit had been reached in fine grinding, the process was carried so far that the remaining half molecule of water was ground out of the plaster. The fact is significant of the amount of grinding required, for this is not an easy thing to do. It is not met with in industrial practice, for "it is not done" though, as Mr. Emley remarks, it was known to be possible. Here, however, is where the more interesting features of the new process crop out, and the "new and useful improvements," in patent office parlance, come in; for it was found that such loss and reduction of the plaster to soluble anhydrite could be prevented by grinding in a closed ball mill, out of contact with the surrounding air.

Grinding in a Closed Mill

What takes place in the humid atmosphere within the mill where the molecules are being broken up and re-forming, is an interesting subject for speculation were there time and space for it, but there is not, within the limits of an article necessarily confined to the practical aspects of the question. It is not said that the finely ground anhydrite, first met with, was not plastic, the probability is, it was, but it is well known to be an unstable body, changing rapidly in moist air, and so will not keep on storing, neither will commercial plaster keep well, for as the writer pointed out in a previous article, it is a much more complex body than is generally supposed, a complexity not revealed by chemical analysis alone.

When, however, the water is not permitted to escape, the result is—the paper says—"a new product." I am not sure in just what sense the term is used. Normal plaster, anyway, is not a new product, and that such a compound is in question here, the present writer is inclined to believe. The fact that it does not alter on exposure to the air seems to point to that conclusion; that it contains the theoretical percentage of water (6.2) is a further proof, for that is the composition of "normal plaster."

If the above conclusion is correct, a number of practical consequences may be drawn from it, which will be hurriedly glanced at. One is that there must be other and cheaper ways of forming "plastic plaster."

Another is that the desirable quality alluded to, that of keeping well on storing, can be imparted in other and less costly ways without the trouble and expense of fine grinding. Such grinding has in fact nothing to do with it. It is a well-known property of normal plaster, is the result of a definite chemical composition, and this last is a function of the temperature of calcination, and varies with it.

Other Ways of Attaining Plasticity

As regards cheaper methods for plastic plaster, it would seem that the production of a finely ground normal plaster is the objective to be aimed at, no matter how this is reached. Then in that case, one of the "continuous" mills of modern type (those which discharge their product as it reaches the required degree of fineness) kept cool by suitable means, even if open to the air, should solve the problem. Or, by somewhat under-calcining the plaster, so as to allow for the loss by grinding, the ultimate object, a normal plaster, or as it is called "hemi-hydrate"—with some saving of time, and coal bills also—might be obtained. Or, a combination of both the above methods might be tried.

A word in conclusion. A neat plaster, even when retarded, has a different "set" from that of a lime and gypsum plaster "finish"; and the wall plastered with it will show re-crystallization of the di-hydrate, or "set" and hardening, taking place in a different way from that of the old-time lime and plaster finish, whether the wall will be better or worse, it is not for the writer to say, but there is a difference.

I do not know if the above comments will miss the eye of investigators or not—the previous article in Rock Products apparparently fared but poorly—but, speaking for himself, the writer has often come upon interesting hints scattered through the esteemed back pages. May one not say of them, what a well-known writer—in a vein of humorous exaggeration—said of the back pages of his paper?

"Files—Office Files!
Oblige me by referring to the Files.
Every question man can raise,
Every phrase of every phase
Of that question is on record in the Files.
It is good to read a little in the Files."

(Kipling.)

Silica Brick in 1920

THE REFRACTORY SILICA brick industry in the United States continued to make progress in 1920. These brick are used principally in by-product coke ovens, in open-hearth steel furnaces, in copper reverberatory furnaces, and in the glass industry, in which they must withstand high temperatures, such as would fuse ordinary clay fire brick. They also withstand abrasion well. The output in 1920, as estimated by Jefferson Middleton, of the United States Geological Survey, Department of the Interior, was 255,000,000 brick, valued at $15,540,000, or $60.94 a thousand, an increase of 18 per cent in quantity and 32 per cent in value as compared with 1919. The quantity marketed in 1920 was exceeded by that in 1917 and in 1918, when the stress of war caused an increase in the production of all refractories. The value in 1920 was exceeded only by that in 1918. The price per thousand in 1920 was the highest recorded. The output in 1920 was 46 per cent greater, the value 307 per cent greater, and the average price per thousand 178 per cent greater than in 1913.

Portland Cement Production Increases in July

MORE CEMENT WAS PRODUCED in the United States in July than in June, and more cement was shipped than was produced, according to figures prepared under the direction of Ernest F. Burchard, of the United States Geological Survey. Both production and shipments in July exceeded the average for July in the last five years.

The production for the first seven months of 1921 is more than 97 per cent of the quantity manufactured in the corresponding months of 1920 and more than 52 per cent of the total production in 1920; the shipments are more than 96 per cent of those for the corresponding period of 1920 and more than 52 per cent of those for the whole year 1920.

Stocks at the end of July were over 1,470,000 barrels larger than on December 31, 1920, and a little above the average for July in the five preceding years, though somewhat less than at the end of June.

The production of clinker (unground cement) during the seven months amounted to more than 53,000,000 barrels, and the July production exceeded 9,000,000 barrels. July stocks of clinker are reported as more than 4,300,000 barrels.

Production, Shipments, and Stocks of Finished Portland Cement in First Seven Months of 1921

Month	Production (barrels)	Shipments (barrels)	Stocks at end of month (barrels)
January	4,098,000	2,539,000	10,300,000
February	4,379,000	3,331,000	11,400,000
March	6,763,000	6,221,000	12,000,000
April	8,651,000	7,919,000	12,600,000
May	9,281,000	9,488,000	12,450,000
June	9,296,000	10,577,000	11,150,000
July	9,568,000	10,301,000	10,414,000
	52,036,000	50,376,000	....

Preventing Fuel Waste in Rotary Kilns

Checking Draft in Cement Kilns Adds Capacity and Economy

THE EXHORBITANT PRICES and acute shortage of coal in Central Europe have called forth intense research in economizing in all fuels, the results of which are often applicable in this country, though coal prices have not advanced to anywhere near the European levels. Peat and lignite are being successfully used in lime-burning and brick-making and where these substitutes for coal can not be utilized the utmost economy is necessitated. One of the most important coal-saving devices is one designed to prevent waste of fuel and product in rotary kilns in cement manufacture, brought out by Dr. Valeur. Carl Naske, C.E. in *Tonindustrie Zeitung* gives this description of the process.

The great advantage which the rotary kiln possesses over the older processes, and which are too well known to require to be enumerated here, are in a measure offset by the large coal consumption. Recognition of this fact has lead to various improvements in rotary kilns since their introduction, but none that have produced a material reduction of coal consumption, so that the superiority of the older methods in this respect still persists.

As one of the reasons for this condition, Dr. Valeur names the fact that rotary kilns are operated with an unnecessarily strong draft, causing very high temperatures at the mouth of the stack and consequent loss of heat. By reducing the draft to required minimum, he reduces the heat loss and at the same time prevents the blowing-out of large amounts of dust along with the combustion gases from kilns and dryers through the stacks. The escape of these quantities of dust represents not only a considerable loss of material and money, but is often the cause of costly judicial procedures on the part of neighbors of the plant who consider themselves injured by the dust and in the case of gardening or agricultural activities are possibly entitled to damages.

Dr. Valeur's process consists in systematically checking the motion of the combustion gases evenly throughout the cross-section of the kiln. Several iron frames covered with steel wire netting serve as checks, the distance of the first frame from the kiln or dryer, the spacing of the frames and the mesh of the steel netting or screens determined by experimenting. The screens will, of course, clog in time and it is necessary to remove them, clean and replace them. This operation requires one or two minutes for each frame and is therefore negligible. If desired, it can be done mechanically, though in most cases this is considered superfluous.

The dust thus retarded by the screens collects at points in the flue, is collected by a spiral conveyor and is returned by a more or less circuitous route to the feed end of the kiln. The quantity of dust regained by Valeur's method is very considerable. At Gmunden, where the process has been in operation for a number of years, the following results were definitely determined: Before the installation 169 kg. of raw material were used to produce 100 kg. of clinker; after the installation only 154 kg. were required, a saving of 8.3 per cent in raw material.

But this does not by any means exhaust the advantages of the process. As already indicated, the systematic checking of the draft resulted at Gmunden in a lower stack temperature, the reduction in this case being from 700 to 600 degrees Centigrade. This not only prevents the overheating of the raw materials, which, in spite of storing in tank, reached the mills too hot, but results also in a material saving of fuel. Coal consumption before installing the device was 26.44 kg. per 100 kg. of clinker, after the installation 23.48 kg., a saving of 11 per cent. At the same time the capacity of the kiln increased about 10 per cent.

Finally the power consumed in powdering the raw materials was reduced from 115 kw.-hrs. per 1,000 kg. of clinker to 106 kw.-hrs. and kiln repairs from 54 days to 36 days per annum.

What these savings expressed in money mean today is easily computed and they gain in significance when it is remembered that the necessary contrivance is so simple that it must pay for itself in a very short time and can be charged off.

Progress of Sand-Lime Brick

Industry Grew in 1920 Notwithstanding Shortage and Inefficiency of Labor, Transportation Difficulties and High Cost of Building

THE SAND-LIME BRICK industry made progress in 1920, according to a report soon to be issued by the United States Geological Survey, Department of the Interior, prepared by Jefferson Middleton.

This industry, like other building-material industries, was handicapped by shortage and inefficiency of labor, transportation difficulties, and the high cost of building. With the resumption of building operations the use of this product should increase rapidly, as it seems to be firmly established in public favor in many localities. Trade in 1920 was generally reported good during the first nine months of the year but very dull after that, due in part no doubt to business and in part to seasonal conditions.

The output in 1920 was 169,761,000 brick, as compared with 146,947,000 in 1919, an increase of 16 per cent. The value of this output in 1920 was $2,490,283, compared with $1,705,163 in 1919, an increase of 46 per cent. The output in 1920 was 73 per cent greater than that of 1918, but 9 per cent less than that of 1917. The value of the sand-lime brick marketed in 1920 reached its maximum and was greater than that of 1918 by 182 per cent, and that of 1917 by 75 per cent. As compared with the output in 1913 that of 1920 decreased 10 per cent, and the value increased 101 per cent.

Seventeen States reported the production of sand-lime brick in 1920. Michigan, as for many years, was the leading State in production and value. Its output was 39,280,000 brick, valued at $640,744, or 23 per cent of the total output and 26 per cent of the total value. These amounts represent a decrease of 7 per cent in output but an increase of 26 per cent in value, as compared with those in 1919. Minnesota, the second State, reported 24,891,000 brick, valued at $290,394, or 15 per cent of the total output and 12 per cent of the value, an increase of 6 per cent in output and of 21 per cent in value. Wisconsin ranked third in output and fourth in value, Florida fourth in output and third in value, and New York fifth in output and value. These five States reported 64 per cent of the output and 63 per cent of the value. The other States that reported sand-lime brick were California, Georgia, Indiana, Louisiana, Massachusetts, North Dakota, Ohio, Pennsylvania, South Dakota, Texas, Washington and the District of Columbia.

The number of operators who reported sales of sand-lime brick in 1920 was 37, the smallest number since 1903, except in 1919, when it was 35.

Practically all this material, 99 per cent, was marketed as common brick, and 1 per cent as face brick. The average price per thousand for common brick in 1920 was $14.61, and for face brick $19.48, as compared with $11.58 and $13.29, respectively, in 1919.

Editorial Comment

Why NOT to Start the Sand and Gravel Business with Limited Capital

THE GREATEST HANDICAP the commercial sand and gravel industry has to overcome is the popular idea that these products are ordinary "dirt" dug out of the ground and sold at an immense profit. It looks so easy to a mere spectator that there may be some justification for such a *popular* misconception.

However, when a periodical ostensibly designed to serve the sand and gravel industry (even though published for free circulation and hence supported entirely by advertisers) prints an article on "How to Start the Sand and Gravel Business with Limited Capital," signed by one of its associate editors, it would seem that this misconception of the real sand and gravel industry is going too far—is being capitalized by those who should be its friends.

ROCK PRODUCTS would be negligent in its duty if it did not immediately lend its assistance to the legitimate sand and gravel industry to overcome the misconceptions, errors and untruths spread broadcast by the article referred to in the contemporary periodical—even if ROCK PRODUCTS had not been particularly asked to do so by representative men in the industry, as has been the case.

From its very beginning ROCK PRODUCTS has fought against such misconceptions of the sand, gravel and crushed-stone industries. It has used every argument and every effort to instill into the minds of every reader, producer or non-producer, that the sand and gravel business is a real business—a real industry—and entitled to all the rights, perogatives and dignity of a real industry. During those years ROCK PRODUCTS can say, with all due modesty but with honest pride, that it was an important factor in organizing the national and many local associations in this industry.

There is no more important service that these associations have done and are doing for the industry than giving the industry the dignity of a real business—and progress along these lines has been rapid and gratifying. There is no longer any excuse for a reputable business man entering the sand and gravel business with his eyes shut. And his eyes are shut and blindfolded if he enters the business "with limited capital" and if he believes the statement made in the contemporary's article referred to that: "By following the suggestions made, it is possible to install plants in pits and banks, where the materials will be worked out in a couple of years, and yet make large profits."

The truth of the matter is, as any business man of sense can see, that the sand and gravel business under average conditions is the riskiest kind of a mining venture. It depends for its very existence on hazards of all kinds. In the first place, it depends on construction, which itself is the most fluctuating of any of the great industries. It is subject to local building booms and depressions. It is subject to the whims and offhand decisions of a very few customers—perhaps not more than a dozen or score of contractors. It is subject to the worst kind of competition from inexperienced and ignorant producers who do not know their real costs. It is subject to all kinds of transportation hazards from the fact that it is the cheapest low grade commodity and therefore suffers most from freight rate increases, car shortages, etc. There is usually such a narrow margin of profit per unit of material that it is about an even chance whether the yearly balance be on one side or the other of the ledger as a result of any one or more of the unforeseen difficulties mentioned.

The idea that a man can build and equip a plant largely on the credit extended him by the machinery people of whom he makes his purchases is absurd. No reputable machinery concern makes a business of financing such enterprises. Likewise a statement that the same machines can be used for stripping, excavating, transporting and elevating the material is absurd, while the suggestion that the same equipment can be used "to store the products and when needed rehandle it from stock piles" is actually ludicrous—and pitiable—to the experienced producer. (The drag-line, which is evidently in mind, while it is very useful, certainly falls far short of being such an all-around, universal sand and gravel money maker. How simple would the sand and gravel industry be if only such things were true!)

To the gravel or crushed-stone man it hardly needs to be repeated that plant storage of these materials is only feasible in special instances and that average rehandling costs ordinarily exceed the margin of profit.

Not to Discourage But to Enlighten

The foregoing is not written to *discourage* the prospective producer. It is only meant to *enlighten* him. If there is a real opportunity for him ROCK PRODUCTS would be the last one to discourage him from taking advantage of it. Neither would any reputable producer discourage him. Our prosperity and the prosperity of the industry we attempt to serve depends on the growth and expansion of the industry. He would indeed be a short-sighted producer who would discourage another man from entering the field, if there was a chance for both to live and prosper, for if any producer is unable to supply the demand at fair prices he is encouraging the use of substitute or inferior materials and thus injuring the whole industry, of which he

must ever be an integral part. Sand, gravel and crushed stone producers are banded together in associations, not to curtail production and discourage competition, but to increase the uses of, the demand for, and therefore the production of their product, and to *encourage fair competition.*

Therefore the prospective producer would do well to seek the friendship and counsel of the men already in the business, either at home or elsewhere. For if such prospective producers have any business brains at all they will seek to know as much as they can about this business, or any business, before embarking in it. The place to get this information is not from machinery peddlers, nor from a contractor who may want to buy 1,000 or 50,000 yds. at the lowest possible price. The proper place to get that information is from reputable producers, or through the columns of a reputable trade journal of these industries.

There Are Real Opportunities!

The prime essential to success in the sand and gravel business, as in any other business, is the ability to sell the stuff you produce. That means you must have a market and not merely an order or two. If the market is already being served in some fashion it means a keen analysis to see what advantages you may have in the market that the other fellow can not have. That may mean proximity, superior material, more economical operation, business connections, or superior salesmanship—but it must mean one or more of these.

In regard to proximity to the market, the matter of freight rates is by no means settled. Undoubtedly adjustments will be made in the near future that will offset any great advantage on this score, at least in many instances. The railways' own interests alone dictate such an eventual readjustment. On the matter of superior material, the prospective advantage would be a good one, for the tendency is constantly toward the use of higher grade materials. But to produce a better material means adequate equipment and an investment in probably no case of less than \$25,000 and in many cases nearer \$100,000. And it means an expert knowledge of the business that cannot be acquired by observing someone else's operations.

Many existing plants represent an investment of from \$250,000 to \$500,000. Obviously this amount of capital would not be tied up in sand and gravel plants by experienced producers, if the production of commercial sand and gravel was such a simple process that any man with one machine and a few dollars could accomplish it. Like any other raw-material producing industry the big profits, if there are any, come from a small differential on large production and not from large differentials on small production. It should go without saying that other things being equal costs of production decrease as the amount of production increases.

As to economical operation and business connections, it need hardly be said that the established producer, if there is one, would most certainly have the advantage under ordinary circumstances. The one item left is salesmanship, and it is a mighty good one. But before entering the sand and gravel business on this advantage alone, it might be well first to see if a more profitable connection can't be made with a going concern.

In conclusion it might be recalled that the sand, gravel and crushed stone industry has attracted about as many inexperienced "suckers" as the oil game. Only in the case of the sand, gravel and stone industry the investors have not only lost their money but often a number of years of their time and maybe ultimately their self-respect.

If you are a genuine fighter, with a fair-sized wad of real money to fall back on, and plenty of moral "sand" as well as a sand pit, if you are willing to put your shoulder to the wheel and help make the sand and gravel business a real business, if you are willing to get out a quality product and stand back of it, as any reputable manufacturer will stand back of his product, if you feel that your business will be a real service to your community—the sand and gravel industry *needs* you, will welcome you and extend the right hand of fellowship to you; and we will all hope you prosper as one having those qualities deserves to prosper.

The Lime Industry

Probably the average industrial chemist has scant respect for the lime industry. He has not been very well acquainted with it. Consequently a perusal of the pages of this issue of Rock Products ought to be interesting to him, and, we believe, ought to convince him that here is a long-neglected branch of his own industry that has been woefully side-tracked.

Not only is lime capable of much greater use in the chemical industries, with mutual profit to the user and the producer, but the industrial chemist may well spend some of his time and effort in aiding the solution of many problems in lime manufacture.

Simple as the operation may appear, a little study will show it is not at all simple if a lime of particular quality or property is desired. While heat is the prime essential in converting calcium carbonate to calcium oxide, don't let it be overlooked that there are 47 varieties more or less of heat.

For example, it is very unlikely that incandescent calcium carbonate would react the same in an atmosphere of hydrogen, as in an atmosphere of carbon dioxide, or in an atmosphere of gaseous sulphur, chlorine or some other chemical reagent. These and many more elements and chemical compounds are present in the limestone, or in the fuel. Which ones accelerate and which ones retard the calcination of the stone? Why does the introduction of steam, or possibly some other gas like carbon monoxide appear to aid calcination? These are only a few problems the lime manufacturer faces, and which await solution by industrial chemists.

Standard Cement vs. Super Cement

German Manufacturers in Controversy

A HEATED discussion of cement standards and possible improvements in the manufacture of cement for special purposes is being carried on in trade papers of Germany, which in view of a possible invasion of our Eastern States by German products in the field and from the similarity of the situation in this country, deserves more than passing notice. From all indications standardizing in Germany will not prevent improvement or the possibility of offering a superior article in international trade. The chief engineer of one of the national railroads has this to say on the matter: "The case of cement is unparalleled in our entire industrial life, where in spite of huge differences in quality, and in technical and economical uses, actually present, the entire products of an important branch of industry, are held at the same price level, and users are given no opportunity to give preference to goods of greater value. This condition was justifiable in the early development of the industry, but must eventually work out to the detriment of the producers themselves."

Before the war it sufficed to threaten the erection of a new mill to extort large sums from the existing establishments, a condition which would not have been possible if the newcomer had had to contend with superior products. The industry, too, could have opened even more fields by introducing special cements of high value, than the activities of users have made possible as it is. The lack of better cement must be considered a great misfortune for our rapidly progressing concrete industry. Only those familiar with the marvelous creations and successes of the concrete engineers, can imagine what these specialists could have accomplished if they had been supported by the cement producers, let us say as the builders of automobiles, ships and aeroplanes were helped by the steel industry. The concrete engineer was handicapped by the quality of his materials. Problems still awaiting his solution can hardly be solved with cement that attains only standard hardness. It is for this reason that concrete ship building and concrete railroad cars, in spite of intense research, are still in their infancy. Months of experimenting were required to produce bridge blocks where a compressive strength of 400 kilograms per square centimeter was required, a strength that can be attained with special cement in possibly an eight-day test.

Not only in such technical problems but in the economical employment of concrete, standard cement has prescribed severe limits; the enormous cost of forms and supports when pillars, beams and floors can not be loaded until six or eight weeks after casting. How important it is for the cement products worker to be able to remove his tile, blocks, brick, etc., from the boards within a day, is apparent from the interest shown in the American process of steam hardening of these products. And even in this process the consumption of coal, labor and the cost of installation are to be considered. Such products made with a special cement attain in two days a firmness reached only after a month if standard cement is used. Special cement, furthermore shows compressive strength in one week that is reached by standard cement products only after months and years and all of this without steaming or any special admixtures in the mortar.

In spite of abundant evidence that quick setting and special strength cements are indispensable to further progress in concrete engineering, the contrary is claimed by the cement producers. It is admitted that superior cement can be produced only by special efforts and that not all mills can greatly exceed the present standards but there is no doubt that if the leaders in cement production can be made to realize the necessity of special products and if the task is attacked with a will, users can be assured a dependable supply of superior cements. (From *Tonindustrie-Zeitung*, Berlin.)

Talc and Soapstone in 1920

Production in 1920 Exceeded That of Any Previous Year

ALTHOUGH TALC IS A MINERAL that is most widely known in the form of talcum powder, it is extensively used in all industries. The pure mineral is known as talc and the massive rock that contains it is known as soapstone. Nine-tenths of the talc and soapstone mined is ground and used as a filler in paper and in rubber, as foundry facing, and in many other ways.

The United States is by far the greatest producer of talc and soapstone, and it consumes even more than it produces. In 1919 it produced 68 per cent of the world's supply and consumed 79 per cent.

The production of talc and soapstone in 1920 exceeded that in any previous year both in quantity and in value, according to Edward Sampson, of the United States Geological Survey, Department of the Interior. The sales in 1920 amounted to 224,290 short tons, valued at $3,090,265, an increase in 1920 over 1919 of 21 per cent in quantity and 31 per cent in value. The quantity exceeded by 2 per cent that of 1917, the previous record-quantity year, and the value exceeded by 15 per cent that of 1918, the previous record-value year.

The quantity of talc reported to the Geological Survey as ground was 178,505 tons, valued at $2,142,894, or 18 per cent more than in 1910. The value of the ground talc was the highest on record, exceeding that for 1919 by 34 per cent and that for 1918, the previous record-value year, by 15 per cent. The average price of ground talc in 1920 was the highest on record, namely, $12 per short ton, which may be compared with $10.55 in 1918 and 1919 and $8.42 in 1913.

The manufactured soapstone sold amounted to 19,707 tons, valued at $709,400, not the highest annual output recorded, but the highest annual value.

Production by States

Vermont led the other states in production, with 86,489 short tons, or 39 per cent of the total quantity, valued at $816,794. New York led in the value of talc produced, but was second in quantity, with 30 per cent of the total, 68,168 tons, valued at $977,228. Virginia ranked third with 10 per cent of the total quantity, 21,715 tons, valued at $729,767. The product of Virginia was mainly manufactured soapstone, hence the large value. Maryland, with 18,027 tons, valued at $72,764, produced 8 per cent of the total quantity. A large part of her output was marketed in the crude state. California produced 6 per cent of the total quantity, her output being 13,199 tons, valued at $232,182, an increase over 1919 of 34 per cent in quantity and 57 per cent in value. The California talc is of very high grade and brings a correspondingly high price. The Pennsylvania-New Jersey talc region produced 5 per cent of the total quantity, or 11,183 tons, valued at 121,302; North Carolina produced 1 per cent of the total, 2,267 tons, valued at $75,474; and the other producing states, Georgia and Massachusetts, produced together 3,242 tons, valued at $64,754.

Another Use for Whitewash

SO CLOSE to the melting point is the asphalt waterproofing coat on the top and side walls of the Galveston causeway that a coat of whitewash has been applied to prevent the paint coat from running. The explanation for this is that white absorbs less heat rays than black, and further that the difference was enough to prevent the melting of the asphalt.—"Engineering News-Record."

General Market News

Illinois Lets Contracts for 51 Miles of Concrete Roads

CONTRACTS for approximately fifty-one miles of cement roads were awarded on Aug. 30 by Gov. Small of Illinois at a cost of $1,474,494, or an average of $28,957 per mile. Had these contracts been let last spring when he refused to pay $40,000 per mile, the roads would have cost the state more than $2,000,000, the governor said.

The contracts were awarded on bids received Aug. 23. At that time bids were also opened for an additional 87 miles of paving contracts, which are still being investigated. (Some 35 miles of these were let Sept. 8.)

Construction Increasing in New York

ALL BOROUGHS in Greater New York are recording increases in construction work. Bronx Borough during the past fortnight has established a new record for volume of plans filed, and Brooklyn is keeping well ahead with its speculative building program. Multi-family apartments and smaller dwellings are absorbing large amounts of material and calls upon the different material yards continue good for this class of work. Industrial operations are slow, with signs of awakening now taking place in the Long Island districts. Leading material men voice the opinion that active fall building will prevail in this district, and present indications well bear out the statement.

While there is nothing of much moment to record with respect to the local material markets, the sentiment has changed considerably during the past month and there is now a firm tone in the different branches of the trade. Practically all materials are in fairly active call, with certain basic products, as cement, lime, plaster, etc., taking the lead in point of sales. Prices are strong at present levels and there is no indication of recession in any important commodity. It is likely that existing figures will maintain throughout the fall and winter.

The building-stone market is enjoying a little better trade in this section and, following the recent decline in prices, the material is holding well at new quotations. Limestone is being used for a number of important projects in this section and the wholesale end of the business is reflecting this activity. Bluestone and granite are also in fair call.

New District of Lime Association Organized

THE NATIONAL LIME ASSOCIATION now has another district office in full swing. This is at Oshkosh, Wis., the headquarters of Districts 6, 8 and 9—the states of Michigan, Wisconsin, Minnesota and the Northwest. Harvey S. Owen is the Director of the new organization.

Mr. Owen was formerly Western District Engineer of the Lime Association. In 1919 he resigned to become chief engineer of the Glencoe Lime and Cement Co., St. Louis, Mo. Before his entrance into the

Harvey S. Owen

lime industry he was a construction engineer with the city of St. Louis, so his experience includes all phases of lime—use, promotion and manufacture.

The new bureau will pay particular attention to the development of the lime plaster and mortar industry.

The directors of the new lime bureau are George Nicholson, Jr., president of the White Marble Lime Co., Manistique, Mich.; Morgan Curtis, president of the Superior Lime Co., Petoskey, Mich.; R. C. Brown, vice-president of the Western Lime and Cement Co., Oshkosh, Wis.; W. A. Titus, president of the Standard Lime and Stone Co., Fond du Lac, Wis.; B. F. Pay, of Fowler and Pay, Mankato, Minn.; and Henry La Liberte, vice-president and general manager of the Cutler-Magner Co., Duluth, Minn.

Prominent Lime Men Visit Rockland Plant

CHARLES WARNER, president of the Charles Warner Co., Wilmington, Del., president of the National Lime Association; C. W. S. Cobb, president of the Glencoe Lime and Cement Co., St. Louis, Mo.; William E. Carson, president of the Riverton Lime Co., Riverton, Va., for many years president of the National Lime Association; J. King McLanahan, Jr., secretary and treasurer of the American Lime and Stone Co., Hollidaysburg, Pa.; and Bernard L. McNulty, general manager of the Mitchell Lime Co., Chicago, Ill., were visitors at Rockland, Maine, on August 27, 28 and 29.

The new Mount kiln plant of the Rockland-Rockport Lime Corporation, which they inspected, is practically completed, but had not operated up to the time of this visit. (This plant was described in detail in the July 2 issue of ROCK PRODUCTS.)

Col. Cobb is a native of Rockland, where his brother, a prominent lawyer and ex-governor of the state, still lives. George B. Wood, president of the Rockland-Rockport Lime Corporation, also acted as host; and a royal good time is reported.

Indicted Kansas Cement Firms Ask Change of Venue

A MOTION WAS FILED in the Reno County Court by the attorneys of the Monarch Cement Co., Great Western Portland Cement Co., Fredonia Cement Co., the Bonner Springs Cement Co., and the Lehigh Portland Cement Co., which firms were indicted by the Reno County grand jury last month, asking for a change of venue. The Ash Grove Lime and Portland Cement Co. was not included in the petition.

The motion charges the Reno County grand jury was illegal because it was hand picked by District Judge Fairchild, that the judge in drawing the jury used "arbitrary and illegal" means to get men of his own choosing on the jury and that he "did not intend that at least eleven lawfully drawn men should be permitted to serve."

General Market News

Massachusetts City Will Truck All Its Stone

THE STREET DEPARTMENT of Haverhill, Mass., has made a change in the method of transportation of crushed stone into the city for street work, abandoning the railroad and using trucks. It is said that by changing from the railway to over-the-road auto transportation a saving of about $62.50 per day will be made to the city. On a 30-day job this will save the interest on a bond issue.

Not only is the new method less expensive, but it will be more satisfactory, Alderman Martin said, according to a local newspaper. There are frequent delays in having the stone come by railroad, the street work being held up at times when cars of stone fail to arrive and then several cars coming together. By the new system there will be a steady arrival of stone and the street work can progress steadily.

Alderman Martin says that he will save 40 cents per ton in transportation charges on the 2½-in. stone, 60 cents per ton on ½-in. stone and 50 cents per ton on dust. (This is about a 20-mile haul.)

The stone comes from quarries in Peabody and Alderman Martin has mapped out the roads for the trucks to travel so that they will not come over Haverhill roads. The trucks will arrive by way of Lawrence and Methuen, reaching the work at Broadway by that route and the stone will be delivered on the job. The deliveries will amount to 125 tons a day.

[Alderman Martin shows thrift and foresight in routing the trucks over the roads of adjoining towns instead of his own.—Editor.]

Disorder Marks Reopening of Fort Dodge Gypsum Mill

WARRANTS charging 10 men with assault with intent to commit murder were sworn out in Fort Dodge, Iowa, following disturbances attending the reopening of the American Cement Plaster Co. plant on August 16. Three street cars carrying employes to the plant were stopped and men taken from them.

The American Cement Plaster plant is the first of Fort Dodge's six gypsum mills to reopen since July 1, when all of the companies announced they were going on an open shop basis. The union men employed at the plants quit work with the announcement. The American Cement Plaster Co. reopened on an open shop basis. Other mills are expected to reopen on a similar basis.

Conditions in Lehigh Valley Cement District

PRODUCTION of cement in the Lehigh Valley district of Pennsylvania continues at a good point. Practically all of the mills are in operation and daily shipments are reaching a normal aspect. In the Coplay section, the average is now from 150 to 165 carloads per day. Large distribution is being made in the eastern districts, with bulk of consumption coming from the numerous road-building operations in Pennsylvania, New Jersey and New York.

The United States attorney's office is growing to be rather a common byword in these parts, for the filing of the recent supplementary indictment against nineteen different cement companies and a number of officers in each shows that the center of attack in the alleged violation of the Sherman anti-trust laws is on the eastern producers. While the matter is one of concern, it is not having any noticeable effect on plant operation and all companies, from the largest to the smallest, are giving required production the right of way.

The Coplay Cement Company is developing a test case with the Pennsylvania Power & Light Company with regard to prevailing rate for power at its mills. A suit in equity has been filed by the cement company against the utility, asking for an injunction to restrain the power company from refusing service should the mill refuse to pay the increased charges now asked. The court is requested to order the power company to accept the rates in force prior to the filing of a schedule for increased charges with the Public Service Commission. The state law gives public service companies the right to establish rates and the consumer cannot obtain a judicial determination of the reasonableness of the rate until it has been investigated by the Public Service Commission. In the case at issue, it is contended that the rate asked for power service at the cement mills is highly excessive.

Death of Daniel Baker

THE LIME INDUSTRY has lost in the recent death of Daniel Baker, president of the Standard Lime and Stone Co., Baltimore, Md., one of its oldest and most substantial members.

Mr. Baker came of a distinguished family of business men, who had been in the lime-manufacturing industry for many years and he leaves sons to carry on his work who have been educated in the lime industry from boyhood.

Mr. Baker's plants are at Bidwell, Pa.; Havre de Grace and Dickerson, Md.; Martinsburg, Millville, Kearneysville and Keyser, W. Va.; Strasburg, Va., and Woodville, Ohio. The recently completed plant at Millville, near Harper's Ferry, is a rotary kiln plant and reputed to be one of the most modern and up-to-date in the industry.

International Cement Corp. Income Nets $1.29 Share

FOR the quarter ended June 30 the International Cement Corp. reported a net income, after charges and taxes, of $348,168, equivalent to $1.29 a share earned on the 268,429 shares of capital stock of no par value, compared with $499,656, or $1.86 a share, earned in the preceding quarter, and $547,591, or $2.09 a share, earned in the corresponding period of the preceding year.

Sales totaled $2,738,988, against $2,297,568 in 1920. Manufacturing profit netted $625,877, compared with $665,800. For the six months ended June 30 net income amounted to $847,874, equivalent to $3.15 a share earned on the stock.

At the same time comes the announcement that Hayden, Stone & Co., brokers of New York City, are offering $1,500,000 five-year 8 per cent convertible gold notes of the International Cement Corp. The corporation, through its subsidiaries, manufactures portland cement in New York, Texas, Cuba, Argentina and Uruguay, its six plants having a total annual production capacity of over 4,500,000 barrels. Net quick assets are approximately 174 per cent, and net tangible assets approximately 923 per cent of this issue.

Earnings of the six plants for 1920, after interest, depreciation and Federal taxes were about 16 times, and for the first six months of 1921 about 14 times the interest on this issue. A sinking fund equal to about 10 per cent annually of the notes outstanding has been provided beginning June 1, 1922.

The notes are convertible into common stock of the corporation at $33⅓ per share. This stock, on which a $2.50 per share dividend is now annually paid, is listed on the New York and Boston Stock Exchanges and is now earning over $5 per share annually. The notes are being offered at 99 and interest yielding 8.25 per cent.

Accident Prevention

Fire Extinguishment

Prepared by the Engineering Department of the National Safety Council

PRACTICALLY EVERY FIRE can be extinguished within the first five minutes if proper equipment is brought into use by men who know how to use it. Successful extinguishment of fires does not, in general, require elaborate, expensive equipment; the essentials are the right kind of equipment (suited to the existing hazards), kept in good condition, in the right place, with men who know how to use it, and that it be brought into use immediately after the fire starts.

No matter how well equipped a plant is with fire-fighting apparatus, nor how well trained the men may be to handle this apparatus, it is of the utmost importance that the public fire department be notified immediately when fire is discovered, in addition to the efforts with private equipment. When men rely wholly upon their own ability to extinguish small fires, serious losses often result which could have been prevented had the public fire department been notified.

Hose

It is almost impossible to tell good from bad rubber-lined hose when it is new, either from its appearance or by putting it under pressure. It is recommended therefore that hose bearing the label of approval of Underwriters' Laboratories be purchased.

The high cost of good hose and the importance of its being in good condition at all times demand that it be given the best of care. Hose should not be kept in a pump house, boiler house, or other warm place, as rubber quickly deteriorates under such conditions. Where hose is folded on shelves or racks it should be changed from time to time with bends at different points to prevent cracking.

Water Pails

Cone or round bottom pails are preferred by many, as they are less likely to be used for other purposes. The flat-bottom pail (bucket) of about three gallons' capacity is, however, recommended, for if an employe carries two pails to a fire he may set one down while he empties the other. Fire pails, water barrels, and water casks should be painted red with the word "Fire" in white letters on them. Their use for purposes other than fire-fighting should be strictly prohibited.

Soda-Acid Extinguishers

The soda-acid extinguisher in common use employs a solution of about a pound and a half of bicarbonate of soda to two and a half gallons of water, with an inner container of approximately four ounces of sulphuric acid. These are made in the "loose stopple" and the "break bottle" types. The latter are especially adapted for railroad and boat service where the swaying and rocking would splash the acid over into the soda solution, thus rendering it useless. By inverting the extinguisher or breaking the bottle the acid is emptied into the soda solution, forming a gas, the expansion of which forces out the solution under considerable pressure.

These extinguishers are valuable in free-burning fires where there is much draught. They are also of value in fighting fire on ceilings or between walls where it cannot be reached by fire pails. Sizes larger than two and one-half gallons' capacity are not recommended because of the inconvenience in handling.

Soda-acid extinguishers must be protected against freezing and for this reason are of little value in locations where protracted cold spells prevail unless they are kept heated. Cabinets (felt or asbestos lined) containing a small electric light beneath the extinguisher, will be adequate protection against the cold. A red glass in door of cabinet, through which light may be seen, will serve to mark the location of the extinguisher box.

Calcium chloride cannot be used in the soda-acid extinguisher, as it reacts with the soda. The use of salt is not advisable because a cold extinguisher of this type does not operate efficiently, and also because the salt will crystallize on the sides and may corrode the extinguisher. These crystals are apt to clog the outlet, thus causing the weakened tank to explode when used. The soda solution also may form crystals on the inside wall of the extinguishers and for this reason they should be examined occasionally.

The acid in the extinguisher constantly absorbs water and, in time, enough water may be absorbed to cause the acid bottle to run over, and acid dropping into the tank will eat into the side of tank around water line. It is advisable, then, that new acid be placed in the bottle once each year when extinguisher is recharged.

Soda-acid extinguishers should be recharged at least once a year. They should be emptied by inverting and playing through the hose as if on a fire, to insure the operation of the extinguisher and also to give employes an opportunity to see how they are operated. Before recharging, the hose and the extinguisher tank should be thoroughly washed.

(To be continued)

Accidents in Sandstone Quarries

QUARRIES PRODUCING sandstone and bluestone throughout the country employed 4,466 men in 1920, according to reports from the operating companies received by the United States Bureau of Mines. The number of workers represents an increase of 836, or 23 per cent, over the previous year.

Accidents caused the death of two men and the injury of 356. Both of the fatal accidents and 281 of the injuries occurred in the pits proper, while 75 injuries occurred at the outside works. Of the accidents in the pits, 38 were caused by handling rock at face of quarry, 36 each by falls or slides of rock or overburden and by flying objects, 35 by haulage accidents, 19 by timber or hand tools, and 15 by machinery. At the outside works 21 persons were injured by machinery, 14 by flying objects, 9 by falling objects, and 6 each by haulage accidents, hand tools, and falls of persons. Based upon the number of men employed and the number of days each man worked, the accident rates for 1920 were 0.56 killed and 100.54 injured per thousand employees, as compared with 0.76 killed and 131.96 injured in 1919.

New Machinery and Equipment

The Superheater Applied to Light Locomotives*

SMALL LOCOMOTIVES, as referred to in this article, include those of 30 tons weight or under, operating on all gauges of track, and are those ordinarily used in all classes of service, such as quarrying operations where heavy grades frequently prevail.

The operation of this class of locomotive differs in one important respect from locomotives used in railway service, in that these small locomotives are not operated for revenue, whereas railway locomotive operation costs are chargeable directly to freight and passenger transportation. Small locomotives are a necessity for the service in which they are used, but their costs of maintenance and operation, which cannot be offset by revenue, must be charged as an expense and included in the overhead of the industry or service in which they are used. With fixed charges already high, it is more important today than ever before to give thought and study to ways and means to reduce operating expenses.

All Modern Locomotives Employ Superheated Steam

One practical way to reduce the operating costs of small locomotives is to equip them with steam superheaters, whereby the full benefits derived from the use of superheated steam are obtained. Every advantage of superheated steam reflects tangible savings in the cost of small locomotive operation. Superheated steam is used today in 40,000 locomotives of all sizes and types; all new power is superheated and the small percentage left of the saturated steam locomotives is fast being modernized by converting them to operate on superheated steam by the application of superheaters. That the railroads, whose locomotives operate for revenue, have practically standardized on superheat is an indication of what superheated steam has accomplished in railway locomotive service. To owners and operators of small locomotives, therefore, the subject of superheated steam becomes a most timely one to consider.

The properties of superheated steam which make for greater economy in small locomotive operation will be better appreciated by a brief explanation of the difference between saturated and superheated steam.

*Reprinted from the "American Lumberman," July 23, 1921.

Boiler Pressure Determines Temperature of Saturated Steam

Saturated steam has the same temperature and pressure as the water from which it is evaporated and with which it is in contact in the locomotive boiler. For each pressure the steam has a definite, constant temperature. At 170 pounds boiler pressure, for example, the steam always has a temperature of 375 degrees Fahrenheit and a volume of 2.47 cubic feet a pound. If more heat is added to the boiler, it is transmitted to and used in evaporating more water but does not increase the steam temperature as long as the pressure remains the same. If heat is taken away from saturated steam in doing work or by cooling, as in the cylinders and in the steam passages to them, part of the steam condenses. The amount of the steam condensed is almost proportional to the heat abstracted, and this condensed steam, or water, is inert so far as capacity for further work is concerned. When the steam, however, has left the boiler and passed into the superheater, it is separated from the water. If heat is now added, its temperature and volume are increased, although its pressure remains the same, and it becomes superheated steam.

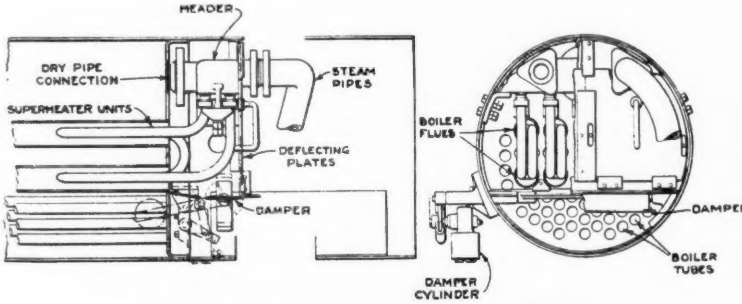
Superheat Saves 35 Per Cent Cylinder Condensation Loss

Superheated steam, which partakes more of the nature of a perfect gas than saturated steam, is a poor conductor of heat and has a larger volume than an equal weight of saturated steam. For example, steam at 170 pounds pressure at 200 degrees Fahrenheit superheat has a volume of 3.27 cubic feet a pound, as against a volume of 2.47 cubic feet a pound for saturated steam at the same pressure. When superheated steam is cooled off in the cylinders it loses part of its superheat but remains steam—that is, does not condense—until all of the superheat has been absorbed. Tests show that in simple saturated switching locomotives using short cut-off, cylinder condensation losses amount to over 35 per cent of the weight of steam admitted to the cylinders. This means that for every 100 pounds of steam delivered to the cylinder only 65 pounds are available in performing work. The condensation loss, as stated above, can be overcome by the use of highly superheated steam, which means an average reduction of 35 per cent in the amount of water and of 25 per cent in the amount of coal used a ton-mile.

Change to Superheat System Is Simple and Inexpensive

Steam is superheated by means of a superheater. In small locomotives the superheater heating surface consists of small diameter steel tubing located in the flues of the boiler.

The installation of the superheater involves the replacement of some of the boiler flues with flues of larger diameter in order to receive the superheater units. Front and rear tube sheets are changed to conform with the altered tube arrangement. However, the change is simple and inexpensive. In operation, steam from the boiler passes through the throttle valve to a saturated steam chamber in the header located in the front end of the boiler. This chamber serves the purpose of distributing the steam uniformly to the superheater units or elements. These units being located in the boiler flues, as before noted, are in direct contact with the gases of combustion at the same time that these gases pass the boiler heating surface. As the steam passes through these units its temperature is raised and it becomes superheated. In this condition it passes from the units to the superheated chamber in the header in the boiler front end, whence it passes to the engine



Superheater installation for a small locomotive

cylinders. It will be appreciated that the control of the steam passing from the boiler to the superheater, and thence to the engine cylinders, is effected by the usual throttle located on the boiler dry pipe.

Does Not Alter Locomotive Design; Adds But Little to Weight

The location of the superheater is of interest not only because its heating surface is in contact with advantageous gas temperatures but also because its position does not alter the original locomotive design insofar as taking up limited locomotive space is concerned. The superheater adds very little weight to the locomotive, an advantage of great importance, especially where temporary trestles are encountered, limiting the power to the weight on the drivers, for, as will be pointed out, superheated steam increases the locomotive's power for the same weight of engine.

Properties Which Make Superheat More Effective and Economical

The properties of superheated steam which make its use more effective and more economical in small locomotives may be briefly outlined as follows:

First: It does not condense until its temperature has been reduced to that of saturated steam at the same pressure.

Second: It has a greater volume per unit of weight than saturated steam at the same pressure. As its temperature increases, so also does its volume.

Third: It has a lower thermal conductivity than saturated steam. Less heat will be absorbed by cylinder and pipe walls per unit of time.

The practical advantages which result from these properties of superheated steam are in general as follows: An increase in locomotive capacity, a saving in fuel and a reduction in the amount of water used by the locomotive boiler.

Superheat Reduces Pounds of Steam Needed Per Horsepower

Because superheated steam has a larger volume per unit of weight, less steam is used by the engine cylinders to produce the same horsepower output. In an engine using saturated steam an average of 27 pounds of steam per horsepower is required; in a superheated engine this steam consumption is reduced to 19½ pounds. This saving in steam becomes still greater because of the elimination of condensation in the engine cylinder. The condensation in small locomotive cylinders where saturated steam is used is ordinarily high; hence there is a great saving which superheated steam affects by eliminating this loss. As a direct result of the saving in water evaporated by the boiler a corresponding saving in fuel consumed under the boiler results from superheating.

Four Superheated Engines Do the Work of Five Saturated

Another direct effect of the reduction in steam consumption is the fact that the capacity of the locomotive is increased. Because the demand on the boiler for steam is reduced, a boiler steam reserve is built up which is available for increased power demands on the locomotive. With the increased capacity available by superheating four superheated engines can do the work of five similar saturated engines —a distinct advantage where small saturated locomotives are worked to the limit of their capacity and service requirements might call for the purchasing of new locomotives.

The Harder the Engine Is Worked, the Greater the Saving

Small locomotives frequently are operated at full capacity. With the cylinders taking steam full stroke, boiler capacity is insufficient to supply the necessary steam. Operating superheated locomotives at full capacity is advantageous, because when boilers are worked hard firebox temperatures are high, resulting in high degrees of superheat. The fact that greater effectiveness and economy result with the higher steam temperatures is an added advantage to superheated locomotives which are worked hard.

By Conserving Water, Superheated Locomotive Avoids Delays

While decrease in fuel consumption and increase in locomotive capacity are very important advantages made possible by the application of steam superheaters, there is still another advantage which in many cases is of importance. That is the reduction in the amount of water used by the engine. This reduction in feed water, due to the decreased amount of steam consumed by the engine cylinders, results in a greater effective engine-tank capacity. Frequently there is a very limited water capacity on small locomotives, especially those of the saddle tank type. By conserving water the superheated locomotive will operate for much longer periods without the delays which otherwise would be necessary to stop and take on water. The time saved is available for useful work, an advantage of importance in the case of small locomotives, because these engines are not operated for revenue.

Superheat Engine Gets Under Way Quicker; Throws Less Smoke

Another important advantage of superheated steam apparent to anyone who has watched a superheated small locomotive at work, or who has operated one, is the fact that the locomotive is "smarter," that it gets under way quicker and saves time in doing its work. It will be observed also that the superheated locomotive operates with less smoke than the saturated locomotive, due to a reduction in the fuel consumed. This fact is an obvious advantage where locomotives operate in logging work where danger of forest fires from sparks is great.

Superheater Enables Small Steam Locomotives to Compete

To manufacturers of small steam locomotives the superheater is of particular interest and value. The application of the superheater places the small steam locomotive on an advantageous competitive basis in point of economy with other types of small motive power. This fact should be borne in mind also by the prospective user of small locomotives and should be carefully considered in the selection of the type of locomotive power best adapted to the service requirements.

A Summary of the Advantages of Superheating

In summary, therefore, the advantages of superheated steam in small locomotives may be stated briefly as follows:

First: A reduction in fuel consumption of 20 to 25 per cent.

Second: A reduction in water consumption of 25 to 35 per cent.

Third: An increase in locomotive capacity of about 30 per cent.

Fourth: An all-round "smarter" and quicker engine.

Fifth: An engine which will handle a greater tonnage in less time.

Sixth: A locomotive which operates with less smoke.

Catalog on Big-Blast Hole Drills

THE Sanderson Cyclone Drill Co., Orrville, Ohio, has just issued Catalog B-45 on Big Blast Hole Drills and their application to quarry, open pit mining and heavy rock excavation. This catalog is now ready for distribution to the trade.

The catalog, besides containing a detailed description of Cyclone drills, goes exhaustively into the subject of big blast-hole drilling and presents considerable valuable information on that subject. Special emphasis is laid on the subject of drilling costs and the examples giving operating and cost data should prove to be a valuable asset to all quarrymen.

The book also goes into complete detail on the subject of blast-hole drilling versus snake holing and blast-hole drilling versus gopher holing. It treats the subject very conclusively and clears up many doubtful points. Besides the above, the book treats with the factors and conditions that govern big blast-hole drilling and also deals with the physical properties of the rock. This book should be in the hands of every producer who finds it necessary to drill and blast rock.

The Rock Products Market

Wholesale Prices of Crushed Stone

Prices given are per ton, F. O. B., at producing plant or nearest shipping point

Crushed Limestone

City or shipping point	Screenings, ¼ inch down	½ inch and less	¾ inch and less	1½ inch and less	2½ inch and less	3 inch and larger
EASTERN:						
Blakeslee, N. Y.	1.00	1.00	1.00	1.00	1.00	1.00
Buffalo, N. Y.	1.30 per net ton, all sizes					
Burlington, Vt.	1.00		2.50	2.00	2.00	
Chaumont, N. Y.	1.75	1.75	1.75	1.50	1.50	1.50
Cobleskill, N. Y.	1.25	1.25	1.25	1.25	1.25	
Coldwater, N. Y.	1.50 per net ton, all sizes					
Eastern New York	.90	1.80	1.70	1.60	1.60	1.50
Eastern Penna.	1.00		1.60	1.60	1.60	1.60
Munns, N. Y.	1.00	1.50	1.50	1.25	1.25	1.25
Walford, Pa.	1.00		1.60	1.60	1.60	1.60
Western New York	.70	1.25	1.25	1.25	1.25	1.25
CENTRAL						
Alden, Ia.	.80@1.00	.80@1.00	1.50	1.45		
Alton, Ill.	2.00		1.50	1.40	1.35	
Bettendorf, Ia.	All sizes, 2.00 cu. yd. f.o.b. quarry					
Buffalo, Iowa	1.00	1.30	1.40	1.20	1.25	1.30
Chicago, Ill.	1.20	1.60	1.20	1.20	1.20	1.20
Columbia, Ill.	2.15	1.90	2.00	2.00	1.90	1.90
Dundas, Ont.	1.00	1.50	1.50	1.50	1.25	1.20
Eden and Knowles, Wis.	1.30	1.30	1.30	1.30	1.30	
Greencastle, Ind.	1.25@1.35	1.25	1.10	1.10	1.10	1.10
Illinois, Southern	1.75	1.60	1.50	1.50	1.40	
Kokomo, Ind.	1.10	1.25	1.25	1.10	1.10	1.10
Krause or Columbia, Ill.	1.60	1.30	1.30	1.30	1.30	1.30
Lannon, Wis.	.90	1.00	1.00	1.00	1.00	1.00
Marblehead and Brillion, Wis.	1.10		1.20	1.10	1.10	
Montrose, Ia.	1.35@1.50	1.50	1.50@1.60	1.50	1.50	1.50
Oshkosh, Wis.	1.40 per ton, all sizes					
Sheboygan, Wis.	1.05@1.10	1.05@1.10	1.05@1.10	1.05@1.10	1.05@1.10	1.05@1.10
Southern, Illinois	1.75	1.60	1.50	1.50	1.50	
Stolle, Ill. (I. C. R. R.)	1.75	1.60	1.60	1.50	1.50	1.50
Stone City, Iowa	.50		1.40	1.35	1.30	
Toledo, Ohio	1.84	1.99	1.99	1.99	1.84	1.84
Toronto, Canada	1.90	2.40	2.40	2.40	2.15	2.10
Valmeyer, Ill.	1.60	1.30	1.30	1.30	1.30	1.30
SOUTHERN:	These prices include 90c freight					
Cartersville, Ga.		1.85	1.60	1.60	1.60	
Chickamauga, Tenn.	1.10	1.00		1.00	.93	
El Paso, Tex.	1.00	1.00	1.00	1.00	1.00	
Fort Springs, W. Va.	1.55	1.70	1.70	1.90	1.45	
Garnet and Tulsa, Okla.	.50	1.60	1.60	1.45	1.45	
Ladds, Ga.	1.50			1.25	1.25	1.25
Morris Spur (near Dallas) Tex.	1.10	1.25	1.25	1.25	1.25	1.25
Portland, Ga.	.60@1.00	(All other sizes 1.00@1.25)				
WESTERN:						
Atchison, Kans.	.50	2.10	2.10	2.10	2.10	2.10
		(Rip-rap.		1.80 per ton)		
Blue Springs and Wymore, Neb.	.20	1.65	1.60	1.55	1.45	1.40
Cape Girardeau, Mo.	1.50		1.50	1.50	1.25	
Kansas City, Mo.	1.00	2.00	2.00	2.00	2.00	2.00

Crushed Trap Rock

City or shipping point	Screenings, ¼ inch down	½ inch and less	¾ inch and less	1½ inch and less	2½ inch and less	3 inch and larger
Baltimore, Md.	1.25	2.50	2.35	2.25	2.00@2.25	2.00
Bernardsville, N. J.	2.00	2.20	2.00	1.80	1.50	
Branford, Conn.	.60	1.50	1.50	1.25	1.10	
Bound Brook, N. J.	2.00	2.30	2.00	1.70	1.60	
Dresser Jct., Wis.	1.00	2.45	2.45	2.30	2.00	
Duluth, Minn.	.75@1.00	2.25	2.00	1.50	1.30@1.50	
Dwight Station, Calif.	.75@1.00—all sizes					
E. Summit, N. J.	2.10	2.35	2.15	1.75	1.75	
Eastern Mass.	.60	1.95	1.75	1.50	1.50	1.50
Eastern New York	.90	1.80	1.70	1.60	1.60	1.50
Eastern Penna.	1.60	2.25	1.95	1.80	1.80	1.70
New Britain, Middlefield, Rocky Hill, Meriden, Conn.	60@ .80	1.60@1.75	1.50	1.25	1.10	
Oakland, Calif.	1.75	1.75	1.75	1.50	1.50	1.50
Richmond, Calif.	.50*		1.75*	1.50*	1.50*	
San Diego, Calif.	.50@ .70	1.45@1.75	1.40@1.70	1.30@1.60	1.25@1.55	1.25@1.55
Springfield, N. J.	2.00	2.40	2.10	1.80	1.75	1.75
Westfield, Mass.	.60	1.35	1.30	1.20	1.10	

Miscellaneous Crushed Stone

City or shipping point	Screenings, ¼ inch down	½ inch and less	¾ inch and less	1½ inch and less	2½ inch and less	3 inch and larger
Alexandria Bay, N. Y.	1.60		1.30	1.50	1.20	
Berlin, Wis.	1.60		1.40	1.50	1.30	
Columbia, S. C.—Granite	.75		2.75	2.50	2.35	
Dell Rapids, S. D.	1.00		2.10	2.10	2.10	
Dundas, Ont.—Flint	1.10	1.10	1.10	1.10	1.10	1.10
Eastern Penna.—Sandstone	1.10	2.00	2.00	1.70	1.70	1.70
Eastern Penna.—Quartzite	.90	1.80	1.55	1.30	1.30	1.10
Holton, Ga.—Granite	.40		2.50	2.25	2.25	2.00
Lohrville, Wis.	1.60		1.30	1.50	1.20	
Los Angeles, Cal.—Granite		1.25@1.50	1.15@1.40	1.15@1.40		
Macon, Ga.—Granite	.50		2.50	2.25	2.00	2.00
Middlebrook, Mo.—Granite	3.50@4.00			2.00@2.25		1.25@1.75
Red Granite, Wis.	1.60		1.30	1.50	1.20	
Sioux Falls, S. D.	1.00		2.00	2.10	2.00	
Stockbridge, Ga.—Granite	.50	2 00	1.90	1.75	1.75	
Utley, Wis.	1.60		1.30	1.50	1.20	

*Cubic yard. †Agrl. lime. ||R. R ballast. §Flux ‡Rip-rap. a 3-inch and less.

Agricultural Limestone

EASTERN:

Chaumont, N. Y. — Analysis, 95% $CaCO_3$, 1.14% $MgCO_3$ — Thru 100 mesh; sacks, 4.50; bulk	2.75
Coldwater, N. Y.—Analysis, 56.77% $CaCO_3$, 41.74% $MgCO_3$, 70% thru 200 mesh, 95% thru 50 mesh, sacks 4.00; bulk	3.00
Grove City, Pa. — Analysis, 94.75% $CaCO_3$, 1.20% $MgCO_3$ — 70% thru 100 mesh; 80 lb. ppr., 5.50; bulk	4.50
Hillsville, Pa.—70% thru 100 mesh; sacks, 4.75; bulk	3.00
Jamesville, N. Y. — Analysis, 89.25% $CaCO_3$, 5.25% $MgCO_3$; sacks, 4.50; bulk	2.75
New Castle, Pa.—89% $CaCO_3$, 1.4% $MgCO_3$—75% thru 100 mesh, 84% thru 50 mesh, 100% thru 10 mesh; sacks, 4.75; bulk	3.00
Texas, Md.—Analysis, 58.02% $CaCO_3$, 37.3% $MgCO_3$—50% thru 50 mesh; bags, 4.25; bulk	2.50
Walford, Pa. — 50% thru 100 mesh, 60% thru 50 mesh, 100% thru 10 mesh; sacks, 4.75; bulk	3.00
West Stockbridge, Mass., Danbury, Conn., North Pownal, Vt.—Analysis, 90% $CaCO_3$—50% thru 100 mesh; paper bags, 5.00—cloth, 5.25; bulk	3.50
Williamsport, Pa. — Analysis, 88-90% $CaCO_3$, 3-4% $MgCO_3$—50% thru 50 mesh; paper, 5.50; bulk	4.00
CENTRAL:	
Alden, Ia.—Analysis, 99.16% $CaCO_3$	.80
Alton, Ill. — Analysis, 96% $CaCO_3$, 0.3% $MgCO_3$—50% thru 4 mes.	4.50
Bedford, Ind. — Analysis, 98.5% $CaCO_3$, .5% $MgCO_3$—90% thru 10 mesh	1.60@2.00
Belleville, Ont. — Analysis, 90.9% $CaCO_3$, 1.15% $MgCO_3$—45% to 50% thru 100 mesh, 61% to 70% thru 50 mesh; bulk	2.50
Bettendorf, Ia.—Analysis, 96.14% $CaCO_3$, 2.5% $MgCO_3$—50% thru 100 mesh, 1.50; 50% thru 4 mesh	1.50
Buffalo, Ia.—90% thru 4 mesh	1.00
Cape Girardeau, Mo.—Analysis, 90% $CaCO_3$, .044% $MgCO_3$ (90% thru 50 mesh, $2.00), 50% thru 4 mesh	1.50
Chicago, Ill.—Analysis, 53.63% $CaCO_3$, 37.51% $MgCO_3$—90% thru 4 mesh	1.50
Columbia, Ill., near East St. Louis—⅛-in. down	1.25@1.80
Detroit, Mich.—Analysis, 88% $CaCO_3$, 7% $MgCO_3$—75% thru 200 mesh, 2.50@4.75—60% thru 100 mesh	1.80@3.80
Elmhurst, Ill. — Analysis, 35.73% $CaCO_3$, 20.69% $MgCO_3$—50% thru 50 mesh	1.25
Greencastle, Ind. — Analysis, 98% $CaCO_3$—50% thru 50 mesh	2.00
Lannon, Wis.—Analysis, 54% $CaCO_3$, 44% $MgCO_3$—90% thru 50 mesh	2.00
Marblehead, O.—Analysis, 33.42% $CaCO_3$, 4.29% $MgCO_3$—52.4% thru 100 mesh, 52.4% thru 50 mesh, 100% thru 10 mesh; sacks, 4.75; bulk	3.00
Limestone screenings; bulk	1.50
McCook, Ill.—Analysis, 54.10% $CaCO_3$, 45.04% $MgCO_3$—100% thru ¼-in. sieve, 78.12% thru No. 10, 53.29% thru No. 20, 38.14% thru No. 30, 34.86% thru No. 50, 22% thru 100	1.50
Milltown, Ind. — Analysis, 93.10% $CaCO_3$, 3.2% $MgCO_3$—33.6% thru 100 mesh, 40% thru 100 mesh	1.50@1.65
Mitchell, Ind.—50% thru 100 mesh	2.00
Montrose, Ia.—⅜-in.	1.35@1.50
Ohio (different points), 20% thru 100 mesh; bulk	1.25@1.50
Piqua, O. — Analysis, 82.8% $CaCO_3$, 8.2% $MgCO_3$; neutralizing power in terms of calcium carbonate, 95.3%—	
50% thru 100 mesh	3.25@5.00
50% thru 50 mesh	1.75@2.00
Ridgeville, Ind.—Analysis, 98% $CaCO_3$ 100% thru 4 mesh	1.75
River Rouge, Mich. — Analysis, 54% $CaCO_3$, 40% $MgCO_3$; bulk	.80@1.40
Stolle, Ill., near East St. Louis on I. C. R. R. — Thru ⅛-in. mesh — Analysis, 89.61% to 89.91% $CaCO_3$, 3.82% $MgCO_3$	1.75
Stone City, Ia.—Analysis, 98% $CaCO_3$ 50% thru 100 mesh	.50
Toledo, Ohio—¼-in. to dust, 20% thru 100 mesh	1.50

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Agricultural Limestone

(Continued from preceding page.)

Whitehill, Ill.—Analysis, 97.12% $CaCO_3$, 2.50% $MgCO_3$—90% thru 100 mesh	5.00
50% thru 100 mesh	1.75
Yellow Springs, Ohio—Aanlysis 96.08% $CaCO_3$, 63% $MgCO_3$, 32% thru 100 mesh; 95.57%, sacked, 6.00; bulk	4.25
SOUTHERN:	
Barber, Va.—Analysis, 92 to 98% $CaCO_3$—Bags, 6.50; bulk	4.50
Blowers, Fla.—Analysis, 98% combined carbonates—75% thru 200 mesh	4.75
Cartersville, Ga.—Analysis, 96% combined carbonates—pulverized limestone	1.75@2.00
Claremont, Va. (Marlime)—Analysis, 90% $CaCO_3$, 2% $MgCO_3$—(90% thru 100 mesh, $4.00), 50% thru 100 mesh	3.50
Dittlinger, Tex.—Analysis, 99.09% $CaCO_3$, .04% $MgCO_3$—90% thru 100 mesh	2.00@3.00
90% thru 4 mesh	1.00@2.00
Grovania, Ga.—Analysis, 95% $CaCO_3$, no $MgCO_3$—50% thru 100 mesh	2.50
Knoxville, Tenn.—Pulverized	2.50
90% thru 100 mesh	2.00
90% thru 50 mesh	1.50
Ladds, Ga.—Pulverized limestone	2.50
Linnville Falls, N. C.—Analysis,, 53% $CaCO_3$; 42% $MgCO_3$—50% thru 100 mesh; sacks, 4.50; bulk	3.00
Mascot, Tenn.—Analysis 52% $CaCO_3$, 38% $MgCO_3$.	
80% thru 100 mesh	3.00
All thru 10 mesh	2.50
80% thru 200 mesh	4.50
Paper bags, $1.50 extra per ton; burlap, $2.00 extra per ton.	
Maxwell, Va.	2.50
Ocala, Fla.—Analysis, 98% $CaCO_3$—75% thru 200 mesh	4.50
WESTERN:	
Colton, Calif.—Analysis, 95% $CaCO_3$, 1½% $MgCO_3$—all to pass 14 mesh; bags, 6.50; bulk	5.50
Sacks, 15c extra, returnable.	
Garnett, Okla.—Analysis, 86% $CaCO_3$, 50% thru 4 mesh	.50
Kansas City, Mo., Corrigan Sid'g—50% thru 100 mesh; bulk	2.00
Terminus, Calif.—Analysis, 96.2% $CaCO_3$, .04% $MgCO_3$—60% thru 200 mesh, 90% thru 100 mesh, 95% thru 50 mesh, 100% thru 4 mesh; sacks, 6.00; bulk	5.25
Tulsa, Okla.—90% thru 4 mesh	.50

Miscellaneous Sands

Silica sand is quoted washed, dried and screened unless otherwise stated.

GLASS SAND:	
Baltimore, Md.	2.25@2.75
Berkley Springs, W. Va.	2.00@2.25
Cedarville and South Vineland, N. J.	2.00
Cheshire, Mass.	5.00@7.00
Hancock, Md.—Damp	2.50@3.50
Klondike and Pacific, Mo.	2.50@3.00
Mapleton, Pa.—Dry	2.50
Damp	2.00
Massillon, Ohio	3.00
Millington, Ill.	1.75
Mineral Ridge, Ohio	3.00
Montoursville, Pa.—Green, washed	1.50@2.00
Oregon, Ill.—Large contracts	1.75
Ottawa, Ill.	1.25@2.25
Pittsburgh, Pa.—Dry, 4.00; damp	3.00
Rockwood, Mich.	3.25@3.50
Round Top, Md.—Damp	1.60@1.75
St. Mary's, Pa.—Unwashed	2.25
Thayers, Pa.	1.75@2.00
Utica, Ill.	1.25@1.75
Zanesville, Ohio	2.50
FOUNDRY SAND:	
Albany, N. Y.—Sand blast	4.50
Core	1.50
Molding fine, coarse and brass	2.00@2.25
Allentown, Pa.—Core	1.50@1.75
Molding coarse	1.50@1.75
Arenzville, Ill.—Molding fine	1.40@1.60
Beach City, O.—Core, washed and screened	2.00@2.50
Furnace lining	2.50@3.00
Molding fine and coarse	2.25@2.50
Bowmantown, Pa.—Core	1.35@1.50
Molding, coarse	1.80@2.00
Cleveland, O.—Molding coarse	1.50@2.00
Brass molding	1.50@2.00
Molding fine	1.50@2.25
Core	1.25@1.50
Columbus, O.—Core	.40@1.25
Sand blast	3.50@4.50
Furnace Lining	2.00
Molding fine	1.50@2.25
Molding coarse	1.50@2.25
Stone sawing	1.50
Traction	.40@ .75
Brass molding	2.50
Conneaut, O.—Molding fine	2.25@2.50
Molding coarse	2.00@2.25

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Wholesale Prices of Sand and Gravel

Prices given are per ton, F. O. B., at producing plant or nearest shipping point

Washed Sand and Gravel

City or shipping point	Fine Sand, 1/10 inch down	Sand, ¼ inch and less	Gravel, ½ inch and less	Gravel, 1 inch and less	Gravel, 1½ inch and less	Gravel, 2 inch and less
EASTERN:						
Attica, N. Y.	.75	.75	.75	1.00	1.00	1.00
Buffalo, N. Y.	1.10	.95			.85	
East Hartford, Conn.			.75 per cu. yd.			
Erie, Pa.		1.00		1.15		1.75
Farmingdale, N. J.	.48	.48	1.65	1.65	1.40	
Hartford, Conn.	.90		1.25	1.15	1.15	1.15
Leeds Junction, Me.		.60@ .75	2.00	1.75	1.65	1.50
Ludlow, Mass.	.75*	.75*	1.70		1.50*	1.50*
Philadelphia, Pa.	.75	.75		1.40	1.25	
Pittsburgh, Pa.		1.30	1.30	1.30	.85	.85
Portland, Maine		.50	1.75		1.35	1.35
Texas, Md.		1.00		Pure white sand, 1.50		
Washington, D. C.	.60@ .75	.60@ .75	2.00	1.40	1.20	1.20
CENTRAL:						
Alton, Ill.		.85				
Anson, Wis.	.50	.50		1.00		.90
Attica and Covington, Ind.	.90	.90	.90	1.00	1.00	1.00
Barton, Wis.		.60	.70	.70	.70	.70
Beloit, Wis.		.60	.60		.60	
Chicago, Ill.		1.75@2.23	1.75@2.43			
Cincinnati, Ohio	.70	.65	.90	.90	.90	.90
Columbus, O.	.90	.90@1.25	.90@1.25	.90@1.25	.90@1.25	.90@1.25
Des Moines, Ia.		.50@ .65	1.60	1.60	1.60	1.60
Detroit, Mich.	.65	.65	.95	.95	.95	.95
Earlestead (Flint), Mich.	.70		60-40 sieves, .85; Pebbles, .95			
Eau Claire, Wis.	.50	.50	1.00@1.25	1.00	1.00	
Elgin, Ill.		.80	1.00	.80	.80	.80
Elkhart Lake, Wis.	.70	.58	.90	.90	.72	.72
Ft. Dodge, Ia.		1.22		2.17		
Grand Rapids, Mich.		.50		.83	.77	.77
Greenville, Mechanicsburg, O.	.80	.70	.80	1.00	.85	.80
Indianapolis, Ind.	.60	.60		1.50	.75@1.00	.75@1.00
Janesville, Wis.		.65@ .75			.65@ .75	
Le Mars, and Doon, Ia.		.90		1.80		
Libertyville, Ill.		.75			.75	
Lincoln, Neb.	Sand .40, sand and gravel .80, drained for shipment					
Mankato, Minn.	.50	.50	.75	.75	.75	.75
Mason City, Ia.	.90	.80	1.90	1.80	1.70	1.65
Milwaukee, Wis.	1.15	1.15	1.25	1.25	1.25	1.25
Minneapolis, Minn.	.35@ .50	.35@ .50	1.50	1.50	1.50	1.25@1.50
Moline, Ill.	.60@ .80	.60@ .80	1.20	1.20	1.20	1.20
Oxford, Mich.		.37		.85	.80	
Riton, Wis.		.40			.60	.60
St. Louis, Mo., f. o. b. cars	1.50	1.65	1.70	1.50		1.45
St. Louis, Mo., delivered on job		2.40@2.55	2.60	2.40	2.40	2.35
Summit Grove, Clinton, Ind.	.75	.75	.75	.75	.75	.75
Terre Haute, Ind.	.75	.75	.85	.85	.75	.75
Winona, Minn.	.60	.50	1.75	1.50	1.25	1.25
Yorkville, Moronts, Oregon and Sheridan, Ill.		.60@ .80	.70@ .80	.70@ .80	.70@ .80	.60@ .80
SOUTHERN:						
Alexandria, La.	.60@ .80					1.20@1.50
Birmingham, Ala.	1.48		all gravel—1.88			
Charleston, W. Va.		(Sand, 1.40@1.50; gravel, 1.50				
Estelle Springs, Tenn.	1.25	1.25	1.00	1.00	.90	.85
Ft. Worth, Tex.		2.00		2.00		2.00
Jackson's Lake, Ala.	.40@ .60	.50@ .60	.40@1.60		.50@1.00	.50
Jedburg, Mo.		1.05	1.20	1.00	1.00	.95
Knoxville, Tenn.	1.15	1.15		2.15	1.95	1.75
Lake Weir, Fla.		.75				
Macon, Ga.		.75@1.00				
Memphis, Tenn.	1.12	1.12				1.95
N. Martinsville, W. Va.	1.10	1.10		1.30		.90
New Orleans, La.	1.00		1.75		1.25	
Pine Bluff, Ark.	1.00@1.25	.80@1.05	Washed gravel, all sizes, 2.20			
Roseland, La.	.25		1.00	1.00		
WESTERN:						
Grand Rapids, Wyo.	.50	.50	.85	.85	.80	.80
Kansas City, Mo.	(Kaw River sand, car lots, .75 per ton, Missouri River, .85)					
Niles, Calif.	1.00	1.00	1.40	1.00	1.00	1.00
Pueblo, Colo.	1.10*	1.00*			1.50*	
San Diego, Calif.	.80@1.00	.80@1.00	1.30@1.60	1.25@1.55	1.15@1.45	1.10@1.40
San Francisco, Calif.		1.00	1.00@1.20	.85@1.00	.85@1.00	.85@1.00
Seattle, Wash.	1.50*	1.50*	2.00*	1.50*		1.50*

Bank Run Sand and Gravel

City or shipping point	Fine Sand, 1/10 inch down	Sand, ¼ inch and less	Gravel, ½ inch and less	Gravel, 1 inch and less	Gravel, 1½ inch and less	Gravel, 2 inch and less
Attica, Covington, Silverwood, Ind., and Palestine, Ill.	.75	.75	.75	.75	.75	.75
Boonville, N. Y.	.60@ .80		.55@ .75			1.00
Cape Girardeau, Mo.			River sand, 1.00 per yd.			
Cherokee, Ia.			.80 per ton—1.20 washed			
Detroit, Mich.	1.10*					
Dudley, Ky. (Crushed Sand)		1.05		1.00		
Elkhart Lake, Wis.			Washed gravel .66			
Estelle Springs, Tenn.						.85
Fishers, N. Y.	.60	.65		.60		.50
Glenville, N. Y.				1.00*		
Hamilton, O.			6 in. and less, .20 per ton			
Hartford, Conn.		1.00*				
Hersey, Mich.				.60	.60	.60
Indianapolis, Ind.			Mixed gravel for concrete work, .65			
Janesville, Wis.		.65			.65@ .75	
Lindsay, Tex.					.60	
Oxford, Mich.				.65	.65	
Pine Bluff, Ark.			Road gravel .60			
Rochester, N. Y.	.60@ .75	.60@ .75			.50@ .65	.50@ .65
Roseland, La.		.75				
Saginaw, Mich., f. o. b. cars		.75	1.30	1.30	1.30	1.30
St. Louis, Mo.			60% gravel, 40% sand 1.70			
Summit Grove, Ind.	.65	.65	.65	.65	.65	.65
Waco, Texas		.80		1.50		1.30
Winona, Minn.	.70					
Yardville, N. J.		.50@ .75				
York, Pa.		1.10@1.20	(crushed rock sand)			

*Cubic yard. B Bank. L Lake. || Ballast.

Crushed Slag

City or shipping point	Roofing	¼ inch down	½ inch and less	¾ inch and less	1½ inch and less	2½ inch and less	3 inch and larger
EASTERN:							
Buffalo, N. Y.	**2.35**	**1.25**	1.25	1.25	1.25	1.25	**1.25**
E. Canaan, Conn.	3.50	1.10	2.50	1.25	1.25	1.25	1.25
Eastern Pennsylvania and Northern New Jersey	2.50	1.20	1.50	1.20	1.20	1.20	1.20
Erie, Pa.	**2.35**	**1.25**	1.25	1.25	1.25	1.25	**1.25**
Emporium, Pa.			1.25	1.25	1.25	1.25	1.25
Lebanon, Pa.	**2.50**	**.85**	**1.50**	**.85**	**.85**	**.85**	**.85**
Sharpsville and West Middlesex, Pa.	**2.00**	**1.30**	**1.70**	**1.30**	**1.30**	**1.30**	**1.30**
Western Pennsylvania	2.50	1.25	1.50	1.25	1.25	1.25	1.25
CENTRAL:							
Chicago, Ill.			**All sizes, $1.50, F. O. B. Chicago**				
Detroit, Mich.			**All sizes, 1.65, F. O. B. Detroit**				
Ironton, O.	2.40	2.15		other grades 1.75			
Jackson, O.	2.00	1.35	1.70	1.35	1.35	1.35	1.35
Stuebenville, O.	2.00	1.40	1.70	1.40	1.40	1.40	1.40
Toledo, O.	2.93	2.30	2.49	2.49	2.49	2.30	2.30
Youngstown, Dover, Hubbard, Leetonia, Struthers, Steubenville, Lowellville & Canton, O.	2.00	1.30	1.70	1.30	1.30	1.30	1.30
SOUTHERN:							
Alabama City, Ala.	**2.05**	**.80**	**1.00@1.25**	**1.15**	**1.05@1.10**	**.85@1.00**	**.85@ .90**
Birmingham, Ala.	**2.05**	.80	1.25	1.15	1.10	.95	.85
Ensley, Ala.	2.05	.80	1.25	1.15	1.10	.95	.85
Longdale, Goshen, Glen Wilton & Low Moor, Va.	**2.50**	**1.00**	**1.25**	**1.25**	**1.25**	**1.15**	**1.05**

Lime Products (Carload Prices Per Ton F.O.B. Shipping Point)

	Finishing Hydrate	Masons' Hydrate	Agricultural Hydrate	Chemical Hydrate	Ground Burnt Lime Blk.	Ground Burnt Lime Bags	Lump Lime Blk.	Lump Lime Bbl.
EASTERN:								
Adams, Mass.						8.00		
Bellefonte, Pa.			11.50		8.00			
Buffalo, N. Y.		11.00	11.00	11.00			9.50	2.00*
Chippewa, Pa.					5.50			
Lewisburg, Pa.					7.50			
Lime Ridge, Pa.					5.75			
Mt. Union, Pa.					7.50			
Paxtang and Le Moyne					5.00			
Rockland, Maine						8.00		
Rosendale, N. Y.					7.00			
Union Bridge, Md.			13.00		5.50			
Williamsport, Pa.			10.00		6.00			
West Rutland, Vt.						7.50		
West Stockbridge, Mass.			15.00					
Williams and Blue Bell, Pa.			11.25					
York, Pa.		11.50	11.50	11.50			8.50	
CENTRAL:								
Alton and Hannibal, Ill.					11.50			
Delaware, Ohio			8.50					
Geneo, Ohio	10.50							
Gibsonburg, Ohio	10.50		8.50					
Huntington, Ind.	10.50	9.00	8.50				8.00	1.70*
Knowles and Valders, Wis.			12.50		5.00	9.00		
Marblehead, Ohio		9.00	8.50				8.00	1.70*
Mitchell, Ind.		12.00	12.00	12.00			9.00	1.75*
Sheboygan, Wis.					5.50	8.50		
White Rock, Ohio	10.50							
Woodville, Ohio			8.50					
SOUTHERN:								
Erin, Tenn.					7.00			
Knoxville, Tenn.			13.00		9.00			
Sherwood, Tenn.	11.00	9.50	9.50	9.30			7.50	1.30
Staunton, Va.					7.50	8.75		
WESTERN:								
Colton, Calif.			15.00					
Kirtland, N. Mex.					12.00			
Los Angeles, Calif.			15.00‡					
San Francisco, Calif.			19.50					

‡100-lb. sacks; *180-lb. net, price per bbl.; †180-lb. net, non-returnable metal barrel.

Miscellaneous Sands

(Continued from preceding page)

Delaware, N. J.—Molding fine ... 2.00
Molding coarse ... 1.90
Brass Molding ... 2.15
Dresden, O.—Core and molding fine ... 1.25
Molding coarse ... 1.50
Brass molding ... 1.75
Dunbar, Pa.—Traction, damp ... 2.75
Traction, damp ... **2.75**
Dundee and Chalfants, O.—Sand blast ... 3.00
Glass, core and traction ... 2.75
Molding fine and brass molding ... 2.25
Furnace lining ... 2.50
Molding coarse ... 2.00
Falls Creek, Pa.—Glass sand ... 2.50
Furnace lining, traction and molding coarse ... 2.00
Sand blast ... 3.50
Eau Claire, Wis.—Core ... .75@1.25
Sand blast ... 3.00@4.25
Traction sand ... .50
Franklin, Pa. and Utica, Pa.—Traction ... 2.50
Brass molding ... 2.25
Core ... 1.50@2.00
Molding fine ... 2.25
Molding coarse ... 2.00
Sand blast ... 5.00
Greenville, Ill.—Molding coarse ... 1.50@1.70
Howard, O.—Glass sand ... 3.00
Molding—Fine and coarse ... 2.50
Core, roofing and brass molding ... 2.50
Furnace lining and traction ... 2.25
Kansas City, Mo.—Missouri River core ... .80
Kasota, Minn.—Molding coarse and stone sawing ... 1.65

Klondike and Gray Summit, Mo.—
Molding fine ... 2.00@2.50
Molding coarse ... 2.50@3.00
Mapleton, Pa.—Core, furnace lining, molding coarse and brass molding ... 2.00@2.75
Molding fine ... 2.25@2.75
Roofing sand ... 2.00@3.00
Sand blast ... 1.50@2.00
Massillon, O.—Glass sand, molding fine and coarse, core, and furnace lining ... 3.00
Traction ... 3.00
Michigan City, Ind.—Core, glass, traction and brass molding ... .60
Millington, Ill. — Glass, core, furnace lining, roofing and stone sawing ... 1.50@1.75
Mineral Ridge, O. — Core, molding, sand blast, roofing, etc., washed, screened (damp) ... 2.50
Montoursville, Pa.—Core ... 1.25@1.50
Traction ... 1.00@1.25
Brass molding ... 1.50@1.75
New Lexington, O.—Molding fine ... 2.25
Molding coarse ... 2.00
Sand blast ... 3.00
Glass, core and traction ... 2.75
Furnace lining ... 2.50
Brass molding ... 2.25
Oregon, Ill.—Core and glass sand ... 2.00
Furnace lining ... 2.00
Molding fine and coarse ... 1.00
Sand blast ... 3.50
Stone sawing ... 2.00
Ottawa, Ill.—Crude silica sand ... 1.00@1.25
Core, molding, fine and coarse ... 1.00@2.25
Furnace lining ... 1.25@2.00
Roofing and traction ... 1.25@5.00
Sand blast ... 4.00@5.00
Stone sawing ... 1.50

Miscellaneous Sands

(Continued)

Ottawa, Minn.—Core ... 1.00@1.50
Glass, molding coarse, roofing, stone sawing (all crude silica) ... 1.00@1.50
Ridgeway, Pa.—Glass sand, green ... 2.25
Glass sand, wash ... 2.50
Molding, fine and coarse ... 1.20
Rockwood, Mich.—Glass ... 3.00@3.25
Roofing ... 3.00@3.25
Sand blast ... 3.50
San Francisco, Cal.—Glass and roofing 3.00@3.50
Core, molding fine and brass ... 2.30@2.60
Furnace lining and molding coarse ... 3.60@4.25
Coarse core sand ... 3.60@4.25
Sand blast ... 2.30@3.60
Stone sawing and traction ... 2.30
Thayer, Pa.—Traction ... 1.75
Furnace lining ... 1.00
Molding fine and coarse ... 1.00
Core, green ... 1.50@1.75
Utica, Ill.—Stone sawing ... 1.25
Furnace lining ... 1.15
Molding, fine and coarse ... .85
Warwick, Ohio—Core, furnace lining, molding fine and coarse (dry) ... 2.50
Same, green ... 2.25
Williamstown Junction, N. J.—Glass sand ... 2.80@2.90
Core, wet ... 2.50@2.60
Zanesville, Ohio — Molding fine and Brass ... 1.50@1.75
Molding coarse ... 1.35@1.50
Furnace lining ... 2.50
Glass, core and traction ... 2.50
Sand blast and steel molding ... 2.50
Pulverized silica thru 140 mesh ... 8.50
Thru 200 mesh ... 9.50

Talc

Prices given are per ton f. o. b. (in carload lots only) producing plant, or nearest shipping point.

Baltimore, Md.—Crude talc ... 4.00
Cubes ... 45.00
Blanks, per lb. ... .08
Biltmore, N. C., ground talc—150-200 mesh, bulk ... 20.00@25.00
Pencils and steel workers' crayons, per gross ... 1.15@ 2.50
Chatsworth, Ga.—Crude talc ... 8.00@10.00
Ground talc (150-200 mesh), bags ... 12.50
Pencils and steel workers' crayons, per gross ... 1.50@ 2.00
Chester, Vt. — Ground talc (150-200 mesh) ... 8.00@10.50
(Bags extra)
Emeryville, N. Y.—150-200 mesh; bags 14.00
Glendale, Calif. — Ground talc (150-200-mesh ... 16.00@30.00
(Bags extra)
Gouverneur, N. Y.—Crude talc ... 4.00
Ground Talc (50-300 mesh) ... 13.50@15.50
Hailsboro, N. Y.—Ground Talc (150-200 mesh) ... 15.00@20.00
Henry, Va.—Crude talc (lump mine run), per 2000-lb. ton ... 2.75@ 3.25
Ground talc (20-50 mesh), bags, 5.75@8.00; (200-350 mesh) bags ... 9.25@13.00
Johnson, Vt.—Ground talc (20-50 mesh), bulk ... 8.00
(Bags extra)
Ground talc (150-200 mesh), bulk ... 10.00@15.00
(Bags extra)
Keeler, Calif.—Ground talc (200 mesh), bags ... 16.62
(Bags extra)
Los Angeles, Calif.—No. 1 (150-200 mesh) ... 15.00@18.00
Ground talc, No. 2 ... 20.00
Silver talc dust, 600 mesh ... 50.00
Natural Bridge, N. Y.—Ground talc (150-200 mesh) bags ... 12.00@15.00
Rochester and East Granville, Vt.—Ground talc (20-50 mesh), bulk ... 8.50@10.00
(Bags extra)
Ground talc (150-200 mesh), bulk ... 10.00@22.00
(Bags extra)
Vermont—Ground talc (20-50 mesh); bags ... 8.00@10.00
Ground talc (150-200 mesh); bags ... 9.00@16.00
Waterbury, Vt.—Ground talc (20-50 mesh), bulk ... 8.50
(Bags extra)
Ground talc (150-200 mesh), bulk ... 10.00@15.00
(Bags extra)
Pencils and steel workers' crayons, per gross ... 1.20@ 2.00

Rock Phosphate

Raw Rock

Per 2240-lb. Ton

Centerville, Tenn—B.P.L. 72% to 75% 6.00@8.50
B.P.L. 65% ... 8.00
Gordonsburg, Tenn.—B.P.L. 68%@72% 5.50@6.50
Mt. Pleasant, Tenn. — Analysis, .75 B.P.L. ... 8.00@10.00
Montpelier, Idaho—70% B.P.L.—Crude 5.00
Crushed 2-in. ring and dried ... 6.00
Paris, Idaho.—2,000 lb. mine run, B.P.L. 70% ... 4.00
Wales, Tenn.—B.P.L. 70% ... 7.75

(Continued on next page)

Roofing Slate

The following prices are per square (100 sq. ft.) for Pennsylvania Blue-Gray Roofing Slate, f.o.b. cars quarries:

Sizes	Genuine Bangor, Washington Big Bed, Franklin Big Bed	Genuine Albion	Slatington Small Bed	Genuine Bangor Ribbon
24x12	$ 9.30	$8.40	$8.10	$8.10
24x14	9.30	8.40	8.10	8.10
22x12	10.72	8.70	8.77	9.10
22x11	10.72	8.70	8.77	9.10
20x12	10.72	8.70	8.77	9.10
20x10	11.70	9.60	9.42	9.42
18x10	11.70	9.60	9.42	9.42
18x 9	11.70	9.60	9.42	9.42
16x10	11.70	9.60	9.42	9.42
16x 9	11.70	9.60	9.42	9.42
16x 8	11.70	9.60	9.42	9.42
18x12	11.05	9.30	9.10	9.10
16x12	11.05	9.30	9.10	9.10
14x10	11.05	9.30	8.77	8.77
14x 8	11.05	9.30	8.77	8.77
14x7 to 12x6	10.40	9.00	8.45	......
	Mediums	Mediums	Mediums	Mediums
24x12	$ 8.10	$7.50	$7.50	$5.75
22x11	9.10	7.75	7.75	5.75
Other sizes	9.10	8.10	8.45	5.75

For less than carload lots of 20 squares or under, 10% additional charge will be made.

Granulated slate per net ton, f. o. b. quarries, Vermont and New Yrok, 7.50

(Continued from preceding page)

Ground Rock

Per 2000-lb. Ton

Centerville, Tenn.—B.P.L. 70%—90% thru 100 mesh	9.00@10.00
B.P.L 75% (brown rock)	12.00
Mt. Pleasant, Tenn — B.P.L. 68%—13% Phosphorus	7.50@9.00
14% Phosphorus	8.00
B.P.L. 65@70%	7.00@9.00
Norwills, Fla.—(Fla. Hard Rock)—B.P.L. 68%	10.00

Florida Soft Phosphate

Raw Land Pebble

Per Ton

Bartow and Norwills, Fla.—B.P.L. 50%, bulk	6.00@ 8.00
B.P.L. 78%, bulk	13.50
Jacksonville (Fla.) District	10.00@12.00

Ground Land Pebble

Per Ton

Jacksonville (Fla.) District	14.00
Add 2.50 for sacks.	
Morristown, Fla.—26% phos. acid	16.00
Lakeland, Fla.—B.P.L. 60%	6.00

Special Aggregates

Prices are per ton f. o. b. quarry or nearest shipping point.

City or shipping point	Terrazzo	Stucco chips
Bound Brook, N. J.—Trap rock, carload lots; bulk		2.30
Chicago, Ill.—Stucco chips, in sacks f.o.b quarries		17.50
Deerfield, Md. — Green; bulk	7.00	7.00
Easton, Pa.—Evergreen, creme green and royal green marble	8.00@10.00	12.00@14.00
Lincoln, Neb. — Red, white, grey, in bags		30.00
Middlebrook, Mo.—Red granite; sacks	30.00@35.00	20.00@25.00
Milwaukee, Wis.	21.00@30.00	21.00@30.00
Missouri river points — Different colors	20.00@25.00	20.00@25.00
Piqua, O.—Marble	8.00@10.00	8.00@10.00
Sioux Falls and Red Granite, Wis.	7.50	7.50
Tuckahoe, N. Y.—White marble	7.00@12.00	10.00
Crushed white stone and marble dust in 100 lb. bags	6.50@12.00	......
Tate, Ga.—White limestone, sacks extra	5.00@ 7.00	5.00@ 7.00
Wausau, Wis.	14.00@18.00	......
Wisconsin and S. Dak. points—Granite, different colors, bulk or sacks	1.50@ 2.00	3.00@ 7.00
Granite dust in bags	6.00	......

Concrete Brick

Prices given per 1,000 brick, f. o. b. plant or nearest shipping point.

	Common	Face
Appleton, Minn.	20.00	30.00@45.00
Bellow Falls, Vt.	20.00	35.00
Birmingham, Ala.	16.00	27.50@50.00
Bridgeport, Conn.	31.00	32.00
Buffalo, Niagara Falls and Rochester, N. Y.	21.00	......
Eau Claire, Wis.	20.00	30.00@40.00
Friesland, Wis.	25.00	......
Houston, Tex.	18.50	21.00
Lockport, N. Y.	17.00	......
Milwaukee, Wis.	17.00@18.00	35.00@65.00
Omaha, Nebr.	26.00	33.00
Piqua, O.	18.00	25.00
Portland, Ore.	25.00	45.00@75.00
St. Paul, Minn.	15.00	32.00
Springfield, Ill.	18.00	20.00@25.00
Tonawanda, N. Y.	20.00	......
Virden, Ill.	18.00	20.00@25.00
Winnipeg, Man., Can.	19.00	40.00

Sand-Lime Brick

Prices given per 1,000 brick f. o. b. plant or nearest shipping point, unless otherwise noted.

Albany, Ga.	8.00
Barton, Wis.	10.00
Bloomfeld, Ont.	16.00
Boston, Mass.	12.50@13.50
Brighton, N. Y.	15.00
Buffalo, N. Y.	16.50
El Paso, Texas (Face 13.00)	12.00
Gary, Ind.	11.50@12.00
Grand Rapids, Mich.	13.00
Lancaster, N. Y.	14.00
Michigan City, Ind.	10.00
Miller, Ind.	10.00@10.50
Milwaukee, Wis. (delivered at job)	14.50
Minneapolis, Minn.	13.00
Plant City, Fla.	10.00
Portage, Wis.—Common	15.00
Face	25.00
Redfield, Mass.	15.00
San Antonio, Texas—Common	16.00
Face	27.50
South Dayton, Ohio	14.50
Syracuse, N. Y. (delivered at job)	20.00
F. o. b. cars	18.00
Toronto, Can.	15.00
Washington, D. C.	13.50
Winnipeg, Can. (less $1 trade disc.)	16.00

Lime

Warehouse prices, carload lots at principal cities.

	Hydrate per Ton Finishing	Common
Atlanta, Ga.	19.00	16.00
Baltimore, Md.	15.00	13.00
Boston, Mass.	24.25	20.00
Cincinnati, Ohio	16.70	14.50
Chicago, Ill.	20.00	......
Dallas, Tex.	25.00	......
Denver, Colo.	30.00	16.00
Detroit, Mich.	15.75	13.75
Fort Dodge, Ia.	19.70	17.00
Genoa, Ohio	10.50	......
Grand Rapids, Mich.	15.65	......
Gypsum, Ohio	13.90	......
Los Angeles, Calif.	......	30.00
Minneapolis, Minn.	29.00	22.00
Montreal, Que.	28.00	......
New Orleans, La.	......	17.25
New York, N. Y.	16.99	......
Oakfield, N. Y.	16.70	......
Plasterco, Va.	19.80	......
St. Louis, Mo.	24.00	20.00
San Francisco, Calif.	25.40	22.00
Seattle, Wash.	27.00	......
	Lump per 180-lb. Barrel (net) Finishing	Common
Atlanta, Ga.	2.00	1.50
Baltimore, Md.	......	12.00
Boston, Mass.	3.40	3.10
Cincinnati, Ohio	......	12.25
Chicago, Ill.	......	1.65
Dallas, Tex.	......	2.75
Denver, Colo.	3.00	......
Detroit, Mich.	2.00	1.80
Los Angeles, Calif.	3.00*	3.00*
Minneapolis, Minn.	......	1.80
Montreal, Que.	15.00†	......
New Orleans, La.	......	1.75
New York, N. Y.	......	3.69*
St. Louis, Mo.	......	1.65
San Francisco, Calif.	......	2.25
Seattle, Wash.	3.50	3.25

*280-bbl. (net). †Per ton.

Portland Cement

Current prices per barrel in carload lots, f. o. b. cars, without bags.

Atlanta, Ga.	2.75
Baltimore, Md. (del.)	2.98
Birmingham, Ala.	2.85
Boston, Mass.	2.86
Cedar Rapids, Ia.	2.51
Cincinnati, Ohio	2.62
Cleveland, Ohio	2.43
Chicago, Ill.	2.17
Dallas, Tex.	2.80
Davenport, Ia.	2.47
Denver, Colo.	3.10
Detroit, Mich.	2.43
Duluth, Minn.	2.10
Indianapolis, Ind.	2.43
Kansas City, Mo.	3.05
Los Angeles, Calif.	3.31
Milwaukee, Wis.	2.39
Minneapolis, Minn.	2.60
Montreal, Que.	2.75
New Orleans, La.	3.20
New York, N. Y. (del.)	2.60@2.70
St. Louis, Mo.	2.90
San Francisco, Calif.	3.09
Seattle, Wash.	3.10
Winnipeg, Man. (del.)	3.86

NOTE—Add 40c per bbl. for bags.

Gypsum Products—CARLOAD PRICES PER TON AND PER M SQUARE FEET, F. O. B. MILL

	Crushed Rock	Ground Gypsum	Agricultural Gypsum	Stucco* Calcined Gypsum	Cement‡ Sand Gauging Plaster	Wood Fiber	White§ Gauging	Sanded Plaster	Keene's Cement	Trowel Finish	Plaster Board ¼x32x36" Weight 1500 lbs. Per M Sq. Ft.	Plaster Board ⅜x32x36" Weight 2000 lbs. Per M Sq. Ft.	Wallboard, ⅜x32 or 48", Lengths 6'-10', 2000 lbs. Per M Sq. Ft.
Alabaster, Mich.	3.50	4.50	......	......	......	......	......	......	......	......	......	......	......
Blue Rapids, Kan.	3.50	4.50	7.50	9.00	11.00	11.50	11.00	......	23.75	20.00	19.375	20.00	36.75
Castalia, Ohio	3.50	6.00	......	......	......	......	......	......	......	......	......	......	......
Centerville, Iowa	3.50@4.20	4.50@7.00	......	......	......	......	......	......	......	......	......	......	......
Douglas, Ariz.	......	......	......	......	......	11.00@12.00	......	......	......	10.50@11.50	......	......	......
†Eldorado, Okla.	......	......	......	......	11.00	11.50	......	......	15.50	......	27.20	29.30	39.55
Fort Dodge, Ia.	3.50	4.50	7.50	9.00@11.00	11.00	11.50	16.45	......	25.80	22.00	19.375	20.00	30.00@35.00
Grand Rapids, Mich.	3.50	4.50@7.00	7.50	9.00	11.00	11.00	19.50	......	27.25	22.00	19.375	20.00	30.00
Gypsum, Ohio	3.50	4.50	7.50	9.00	11.00	11.00	20.25	8.00	27.95	20.00	19.375	20.00	30.00
Gypsumville, Man.	3.50	......	......	......	......	......	......	......	......	......	......	......	......
Hanover, Mont.	5.00	......	......	......	......	......	......	......	......	......	......	......	......
Loveland, Colo	3.50	4.50	7.50	9.00	11.00	11.50	......	......	29.80	......	......	......	......
Oakfield, N. Y.	3.50	4.50	7.50	9.00	11.00	11.00	21.20	7.50+	28.25	22.00	19.375	20.00	30.00
Piedmont, S. D.	......	......	7.50	9.00	11.00	11.50	......	......	32.25	......	27.97	31.04	41.18
Plasterco, Va.	4.50	......	7.00	9.00	11.00	11.00	21.90	......	29.90	20.00	21.375	22.00	......
Rapid City, S. D.	5.00	......	......	......	......	......	......	......	......	......	......	......	......
†Southard, Okla.	3.50	4.50	7.50	9.00	11.00	11.50	11.00	......	15.50	......	26.20	28.70	39.40

NOTE—Returnable Jute Bags, 15c each, $3.00 per ton; Paper Bags, $1.00 per ton extra.

* Shipment in bulk 25c per ton less; †Acme, Tex., freight rates govern; ‡Bond Plaster $1.50 per ton additional; +Sanded Wood Fiber $2.50 per ton additional; §White Moulding 50c per ton additional.

News of All the Industry

Incorporations

Laval Quarry, Montreal, has been registered.

The Cape Henlopen Sand Co., Lewes, Md., has been incorporated for $100,000.

The Building Materials Co., Norristown, Pa., has increased its capitalization from $200,000 to $350,000.

Falconer Coal, Gravel and Supply Corp., New York, N. Y., has been incorporated for $50,000 by M. Lindquist, G. Josephson and T. Anderson.

The Sand-Lime Products Co. has been incorporated in Detroit, Mich., with a capital of $50,000.

The Speers Sand and Clay Works, Wilmington, Del., has been incorporated for $300,000 to engage in the mining of sand, ores, etc.

The Standard Sand and Gravel Co., Kewaunee, Wis., has been incorporated for $10,000 by T. J. Fedders, C. L. Peterka and George Shaskett, all of Kewaunee.

Summit Marble Co., Watertown, Wis., has changed its name to Summit Marl Co. and has increased its capital stock from $6,000 to $15,000. E. F. Genrich is president.

The Superior Lime Corp., Brooklyn, N. Y., has been incorporated for $5,000 by S. Briggs, M. and B. F. Solomon; attorney, A. H. Goodman, 1482 Broadway, New York City.

The Sherborn Stone Co., Sherborn, Mass., has been incorporated for $700,000 by A. M. McGinness, L. Meynell and S. T. Woleyks, 12 Hilburn Place, Roslindale, Mass.

Westmount Construction Co., Ltd., Montreal, has been incorporated with a capital of $15,000 to carry on a quarry business and deal in stone, sand and cement.

The Randolph Sand & Gravel Co. has been incorporated in St. Paul, Minn., by J. P. Langford, Davenport, Ia., and J. A. Burnquist, 1504 Merchants National Bank Bldg., St. Paul, Minn.

The Massillon-Greenville Gravel Co., Greenville, Ohio, has been incorporated for $300,000 by C. E. Patty, H. R. Brown, J. G. Stewart, Guy C. Baker and Fred R. Jones.

Brittain Sand and Gravel Co., Ltd., Brantford, Ont., has been incorporated with a capital of $40,000, by A. Brittain, W. H. Luff and others, to deal in sand and gravel.

The Badger State Granite Co., Eau Claire, Wis., has been incorporated for $25,000 to manufacture and deal in monuments and ornamental stoneware and to engage in quarrying.

The P and Z Tile and Cast Stone Co., Brooklyn, N. Y., has been incorporated for $10,000 by B. Carpenter, G. Zappia and P. J. Belpuletci; attorney, L. Epstein, 99 Nassau St., New York City.

The Beyer Marbelite Co., New York, N. Y., has been incorporated for $300,000 to manufacture marble and patented products. The incorporator is R. W. France, 72 Seventh Avenue, New York City.

The P. C. Lavoie Co. has been incorporated in Baltimore, Md., with a capital of $50,000, to handle all kinds of building material. Incorporators are Peter C. Lavoie, Henry Massart and Benj. L. Freeny.

H. A. Wickett Co., Ltd., Toronto, has been incorporated with a capital of $40,000 to do construction work and to manufacture and deal in cement, cement products, artificial stone, sand, lime, plaster, etc.

The Badger Concrete Co., Oshkosh, Wis., has been incorporated for $25,000 to manufacture and deal in all kinds of products manufactured from cement, stone, granite, marble, etc. The incorporators are Henry Barber, F. B. Keefe and Chris. Olson.

The Minneapolis Crushed Stone Co., Aberdeen, S. D., has been incorporated for $150,000 to engage in the quarry business. The incorporators are G. S. Johnston, A. W. Harwood and J. R. Leonard, of Aberdeen. The company is also qualified to do business in Minnesota, with location at 592 Met. Bank Bldg., Minneapolis.

The Akka Cement Products Co., New Kensington, Pa., has been incorporated under Delaware laws to manufacture concrete and cement products. The incorporators are James L. Thompson, Harry A. Rawlinson and Malcolm Stepp, New Kensington. The company is represented by the Capital Trust Co., Dover, Del.

The Goodwin Building Specialty Co., Milwaukee, Wis., has been incorporated for $15,000 to manufacture and deal in products manufactured from cement, stone, lime, plaster, etc. The incorporators are Ed. B. Goodwin, A. G. Wellhausen and Walter F. Mayer.

The Oakfield Gypsum Products Corp., Batavia, N. Y., with a capital stock of $150,000, is the title of a new corporation which will mine and quarry gypsum and manufacture lime, stucco and building materials. Its headquarters will be located in Alabama. The company will begin business with $75,000 and the three directors each holding 250 shares are Joseph R. Swan, of New York; J. Lindsey Hughes, of Utica, and George F. Weaver, of Deerfield, Oneida County.

Quarries

The Georgia Marble Works, Tate, Ga., has suffered a fire loss of about $100,000.

The Stone Products Co., Bedford, Ind., has filed a final certificate of dissolution with the Secretary of State.

Barre, Vt.—The granite manufacturing plant of Biachi & Son at Barre, Vt., was damaged by fire Sunday to the extent of $100,000.

The Southwest Marble Co. has been incorporated in Knoxville, Tenn., with a capital stock of $10,000, by John J. Craig and T. O. Cusick.

The Indiana Limestone Quarrymen's Association has announced a change in its principal place of business from Bloomington, Ind., to Bedford, Ind.

The Worlock Stone Co., Perryville, N. Y., is planning for the addition of an agricultural limestone plant to its present crushing plant. The company expects to spend about $25,000 on this enterprise.

The Santa Clara County Board of Supervisors, San Jose, Calif., has purchased for $85,000 a large quarry and crushing plant near Saratoga. According to a local newspaper report the county supervisors are congratulating themselves that the purchase of the quarry will virtually stamp out competition of road construction corporations as the county will now be able to outbid all others. The quarry was owned by James J. Stanfield, Mrs. F. W. Knowles, Harry B. Reynolds and Frank B. Willard. Equipment on the quarry site is in good condition, it is said.

The Brookfield Quarry and Towage Co., Brookfield, Wash., is just completing a new wharf, warehouse and bunkers at Astoria, Ore. Organized in 1916 by Chas. Larson, the Brookfield Quarry & Towage Co. has successfully operated a rock quarry and crushing plant at Brookfield. The increased demand for rock and sand has prompted the company to build a capacious bunker at the new site, which will considerably facilitate local deliveries. They will also handle coal for domestic and commercial purposes, as well as carrying a full line of builders' supplies. Their already extensive floating equipment has been recently increased by the addition of new scows and an up-to-date and powerful steam dredge.

The Lincoln Crushed Stone Co., Lincoln, Kans., is making progress in the construction of its new plant. E. F. Decker, secretary-treasurer, has taken charge of the work. He will remain in Lincoln a part of the time and the active management and control of the business will be vested in Mr Decker and a resident manager at Lincoln. J. C. Paslay, president, and F. S. Munch, vice-president, will remain here and will be associated with the business in inactive capacities. The quarry is located on the Salina Northern R. R. at Lincoln. Official laboratory tests of the product by the Kansas State Agricultural College show this stone to be the best highway material in this part of the country. Mr. Decker reports that sales of 10,200 tons of stone have already been made and the prospective demand is very large. Mr. Decker will retain his interest in the Cement Silo Co. at Salina and expects to be here at least once a week. W. A. Dehner will have charge of the silo plant while Mr. Decker is absent.

Silica Sand

The Ohio Flint and Glass Sand Co., Janesville, Ohio, has been incorporated for $100,000 by C. A. Bradford, A. A. Bradford, F. K. Pence and D. W. Downhour.

The Youngstown Silica Sand Co., Youngstown, Ohio, will establish a $35,000 sand crushing outfit at Leesburg, Pa. R. C. Krause is president of the company.

Sand and Gravel

The Myers Gravel and Sand Co., Anderson, Ind., has announced a capital stock increase from $10,000 to $40,000.

The Callahan Construction Co., of Dallas, Tex., will operate a gravel pit near Ennis, Tex. A spur track is being run to it from Ennis.

The Oregon City Sand and Gravel Co., Oregon City, Ore., has been incorporated for $125,000 by F. P. Morey, J. H. Yates and S. L. Wallace, all of Oregon City.

The Consolidation Sand and Gravel Co., an Illinois corporation, has qualiled to do business in Indiana, 1000 shares of its stock being represented in this state. Chas. S. Lundin of Knox, Ind., is named as state agent.

The Allen Gravel Co., 2 Odd Fellows Bldg., Memphis, Tenn., reports good activities in Tishomingo gravel, in which they are interested, with pits in Mississippi. The probable shortage of cars in the autumn is precipitating a good summer movement.

The Burris Gravel Co., Shoals, Ind., has succeeded in obtaining freight rates which will enable it to operate with a full force at once. It is a big bidder on state highway projects and was working under a handicap with regard to excessive freight rates.

Sheehan Brothers, for many years in the sand and gravel business at Stoughton, Mass., have erected a building for the manufacture of hollow building brick. The brick are made from a compound of cement and gravel and already the concern is finding a good market for its output.

The Southern Sand and Gravel Co., Memphis, Tenn., has been incorporated for $100,000 to engage in the gravel business, together with the mining of coal, lead, zinc, etc. T. L. McCourt, one of the incorporators, is a widely known quarry operator of this city. He operates a large quarry near Williford, Ark., and also one in Mississippi. The other incorporators are Phil M. Canale, J. E. Holmes, Leo L. Cole and John W. Loch.

The Carolina Sand and Gravel Co., Carthage, S. C., which recently underwent a change in ownership, has more than doubled its output and is now shipping from 40 to 50 cars of gravel weekly. The payroll has also been doubled, a number of men having been given regular employment. J. C. Bible, superintendent, was recently promoted to sales and credit manager, and Mr. Crane, of Wilmington, took charge as production manager.

The Underwood-Walker Co., Birmingham, Ala., has just completed and put into operation its new sand and gravel plant at Prattville Junction, Ala. The plant represents an investment of $50,000 worth of new machinery and has a capacity of 50 cars of sand and gravel per day. The material is mined by a 10-in. centrifugal pump located on a 30x60-ft. barge with 5-ft. water draft. The pump is belt run from a 150-h.p. crude oil engine, which also generates enough power to run the other machinery necessary for operation.

The Granite Sand and Gravel Co., Indianapolis, Ind., recently made a proposal to the Indianapolis Board of Park Commissioners whereby the company would turn over to them without charge a lake, three-fourths of a mile long and half a mile wide, south of Kentucky Avenue and west of Harding Street. W. K. Miller, president of the company, stated that they intended to remove gravel from about 100 acres, thus forming the lake. The lake would have a capacity between 800,000,000 and 1,000,000,000 gallons of water and 100,000,000 gallons could be removed daily without seriously affecting the level, thus solving the future water supply of the city. The gravel company's offer hinges on the city lending the company $300,000 to be repaid in 25 yearly installments, and on condition that if the park

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board ever acquired an adjoining tract of land which contains a bed of gravel, that the company would have exclusive rights to remove the gravel at $3,000 an acre or 5 cents a ton. Park commissioners said the offer could not be accepted legally as it stands because the city cannot lend money to a private individual or firm, but that proposal may be altered so as to comply with the law by buying the entire area for $300,000 and then lease it to the company for sufficient to pay interest on bonds. The lake, under contemplation, could be used for bathing, boating and fishing and would provide a summer pleasure spot which has been desired by the park board for some time.

Cement

The Zimmerman Cement Co., Dickinson, N. D., is reported to have put up a cement plant in Winnett, Mont.

The Santa Cruz Portland Cement Co., San Francisco, Calif., was recently awarded the contract for 50,000 bbls. of cement to be used in the construction of the Don Pedro dam in Turlock, Calif.

The Alpha Portland Cement Co. closed its plant at Cementon, N. Y., for an indefinite period. It is stated that the shutdown was for the purpose of disposing of the accumulated cement on hand, and that the date of reopening could not be stated.

The Lehigh Portland Cement Co., Metaline Falls, Wash., closed its plant down on July 30 for a period of two months. During this time the company will install a new tramway from its quarries to the mill. About 35 men will be employed while this work is in progress. The plant has been operating two shifts and as the demand for cement has been below production a surplus of about 150,000 barrels has been piled up in the storage bins.

The Canada Cement Co., of Belleville, Ont., has been incorporated by A. A. Huck, plant superintendent; G. A. King, yard foreman; W. J. Armstrong, plant paymaster; W. A. Sutherland, chemist, and E. R. Abbott, engineer, with head office at Belleville, to operate a combination club boarding house for the accommodation of employees of the Canada Cement Co., Ltd., at plant No. 5, to provide games for members and to sell tobacco, ice cream, soft drinks, etc.

B. M. Updike, Box 1266, Memphis, Tenn., writes as follows: "I am organizing a company to go into the cement game. We are amalgamating a number of interests and would consider taking over a plant anywhere that could be converted into our use. We shall go into the crushed stone business along with the other. If you know of any plant or company having a plant that we could take over in our new one, I shall appreciate your able assistance. Would also consider taking over a stone-crushing plant."

Hanover, Ont.—Several alterations have been made to the plant of the Hanover Portland Cement Co., Hanover, Ont. It was recently decided to use limestone rock instead of marl as one of the raw materials of the company's product, and the change has entailed the installation of additional machinery to grind the rock and take care of the increased output of the factory. The output of the mill has been increased from 70 to 1,200 barrels per day. In order to obtain this increase one 8x8-ft. P. & M. ball mill driven by a 20-hp. Westinghouse squirrel cage motor, and one 5x22-ft. Bonnot tube mill driven by a 150-hp. motor, have been added to the wet raw grinding department, and one 8x8-ft. P. & M. ball mill driven by a 200-hp. motor, has been added to the clinker grinding department. Mitchell electric vibrating screens have been installed in the raw, clinker and coal mills. Tunnels with belts and elevators have been built under the rock and clinker storages to facilitate handling these materials, and all other elevators and conveyors have been changed. The plant has been re-wired and the wires put in conduit. The company has two water powers in the Saugeen River and additional power is purchased from the Hydro-Electric Commission. The limestone is quarried near Walkerton and is exceptionally pure calcium limestone, analyzing over 98 per cent calcium carbonate. It is crushed to pass through a two-inch ring and is delivered in railway cars. The material is unloaded either into storage or into the mill bin directly from the cars by a 15-ton link-belt locomotive crane.

Lime

The Limeton Lime Co., of Limeton, Va., has increased its capital stock from $20,000 to $50,000. R. E. Ferr, Front Royal, Va., is president.

Gypsum Products

The California Gypsum Corp., 731 Pacific Finance Building, Los Angeles, Calif., has preliminary plans under way for the construction of a new plant on property recently acquired in the vicinity of Coyote Wells, Imperial County. The plant will consist of a number of buildings, with a main one-story plaster mill, and auxiliary structures for finished product manufacture, estimated to cost about $350,000, with machinery. A modern rock crushing plant will be installed, with crushing machinery, quarrying equipment, steam shovel, etc., estimated to cost about $100,000. A railroad line, narrow gauge, will be constructed from the the plant site to a connection with the San Diego & Arizona Railroad, about 16 miles distant, estimated to cost in excess of $200,000, including cars and other rolling stock. Work on the project will be inaugurated at an early date, and preliminary surveys are now under way.

The New Red Beach Plaster Co., Boston, Mass., is operating gypsum properties at Hopewell Cape, New Brunswick, and Stanley, Nova Scotia, and the crude material is shipped to Red Beach, Maine, where the company has a plant equipped to manufacture 100,000 barrels of gypsum plaster and to grind 50,000 tons of gypsum fertilizer rock annually. The company owns its own water power, wharves, and extensive water-front and has factory buildings, stores and houses at the quarry and at the plant. Dr. John D. MacKenzie, formerly instructor in the Geological Department at Cornell University and now connected with the Massachusetts Institute of Technology, reports that there are from 3,000,000 to 5,000,000 tons of gypsum in the company's properties. The Hopewell Cape quarry produces a very fine grade of gypsum for making plaster of paris suitable for dental use, moulds, etc., and the Stanley quarry grade is more suitable for building purposes and for use as fertilizer. The management of the plant is in the hands of Clarence Tarr. The president of the company is E. C. Tarr, secretary; Francis V. McCarthy, treasurer, and Charles Matlack. The company's Boston office is at 31 State Street.

Concrete Products

The South Side Concrete Co., of Jacksonville, Fla., is in the market for concrete block machinery.

The Everett Concrete Products Co., 2941 Chestnut St., Seattle, Wash., is turning out architectural trim stone.

The Progressive Cement and Tile Works, Pottsville, Pa., is reported to have definitely decided to locate a plant at Hazelton, Pa. Plans are already under way to market a line of concrete products.

The Kelsite Stone Products Co., Kelsy City, Fla., will install about $10,000 worth of machinery to make blocks, bricks, roofing tile, wall tile, etc. H. C. Mitchell, West Palm Beach, Fla., is president.

Hamilton, Ont.—A plant is being erected at Hamilton by the National Slag Products, Limited, for the purpose of making building tile, brick and roofing material from slag from the Steel Co. of Canada. The plant will have a capacity of 6,000 5x8x12-in. tile per day. The men behind the project are well known manufacturers, engineers and business men. W. H. Yates, of Hamilton, is president; David Dick, Welland, vice-president; J. P. Anglin, Montreal; Hon. G. D. Robertson, Ottawa; H. J. Daly, Toronto; W. R. Fleming, Toronto; Gordon Hutton and E. J. Robertson, Hamilton.

Phosphate Rock

The Virginia-Carolina Chemical Co. has been awarded reparation of about $1200 on account of unreasonable freight rates on fertilizer shipments.

The American Phosphate Corporation, Montpelier, Idaho, has begun the shipment of 15,000 tons of dried rock to Los Angeles, Calif. The company will shortly install a new large air compressor.

The Montana Phosphate Co., Maxville, Mont., claims to have the largest single-bed phosphate deposit in the world. This company also owns valuable limestone property. F. J. Russell, Spokane, Wash., is president of the company; Dr. F. A. Bryant of Colfax, Wash., is vice-president, and F. S. Irwin of Teoka, Wash., is secretary.

Sand-Lime Brick

The Acme Brick Co., Milwaukee, Wis., has ust issued an interesting folder describing uses of sand-lime brick in Milwaukee. The folder is very well illustrated with views of buildings in which sand-lime brick was used.

The Adamantex Brick Co. has been organized, with a capital of $1,000,000, by George B. Clemmer, 1024 North Charles Street, Baltimore, Md., and Everett M. Aten, Washington, D. C., to manufacture sand-lime brick, and will put up a plant in Arbutus, Md., with a capacity of 240,000 brick per day.

Personal

W. H. Andrus, 436 St. James Place, Chicago, Ill., wishes to act as a broker for companies engaging in the manufacture of extremely white limestone for use as a whiting or as a pigment for paints.

F. P. Monaghan, superintendent of the Glens Falls Portland Cement Co., Glens Falls, N. Y., has been appointed chairman of the building committee for the new Knights of Columbus home in Warren St., Glens Falls.

Geo. B. Massey, consulting engineer, specializing in projects involving large amounts of excavation, with offices in Peoples Gas Bldg., Chicago, sailed on Sept. 3 from New York for a six months' business trip to Europe and Asia.

E. G. Law has leased the Windmill Point quarries of the Standard Crushed Stone Co., Ltd., Niagara Falls. Mr. Law has overhauled the plant and proposes using the whole output on road contracts he has secured in Welland County.

Samuel Rickwood, who for a number of years operated a stone yard in Evansville, Ind., which he closed during the world war because of the difficulty experienced in getting labor, has accepted the position as superintendent of the Caden Stone Co., of Evansville, to take the place of Arthur Capella, who died several months ago.

George Olsen, at one time an associate editor of Rock Products and recently secretary of the Wisconsin Building and Fuel Merchants Association on August 1 joined the sales department of the Farley Hopkins Co., Chicago, miners, shippers and dealers in coal. During Mr. Olsen's three years with the Wisconsin building supply dealers he increased their association membership from 55 to 443.

B. G. Dann, who for the past four years has been connected with the engineering department of the Truscon Steel Co. in Youngstown and New York City, has resigned to accept a position as manager of the New York office, 30 Church Street, of the Hendrick Mfg. Co., maker of perforated metal screens, elevator buckets, general sheet and light structural work; also light and heavy steel plate construction. Mr. Dann is a graduate of the engineering department of Lafayette College.

Obituary

Willis S. Phelps, proprietor of the Redstone Quarry, Burlington Vt., died suddenly on Aug. 6 of heart trouble. Mr. Phelps had suffered from heart trouble for some time, but of late had been improved and his fatal illness was of only about 12 hours' duration. He is survived by his wife and one sister, who resides in Nebraska. He was a member of Burlington Lodge of Elks, and was well and favorably known. He was 65 years of age, having been born in 1856.

Used Equipment

Rates for advertising in the Used Equipment Department: $2.50 per column inch per insertion. Minimum charge, $2.50. Please send check with your order. These ads must be paid in advance of insertion.

NO. 8-D, GATES GYRATORY CRUSHER

STANDARD DRIVE

Fitted with manganese head and concaves. Included with this crusher, we have the following extra spare parts:

- **1 New, Manganese head.**
- **1 New, set of manganese concaves.**
- **1 New, main shaft.**
- **1 New, Spider, and 2 New, eccentrics.**

We also have many other sizes and types. We specialize in good quarry equipment of all classes. Write us fully.

Reading Engineering Co., Inc.
1227 Tribune Bldg., New York, N. Y.

New Rubber Belting

300 ft.	12"	6-ply	$0.99	per foot
423 ft.	14"	5-ply	1.04	per foot
527 ft.	14"	6-ply	1.25	per foot
529 ft.	16"	6-ply	1.39	per foot
520 ft.	16"	8-ply	1.90	per foot
150 ft.	18"	6-ply	1.48	per foot
512 ft.	18"	8-ply	2.00	per foot
216 ft.	24"	8-ply	3.15	per foot

Rolls Cut to Any Length

National Belting and Salvage Company
268 East Water Street Milwaukee, Wis.

IMMEDIATE DELIVERY

NO'S. 6, 7½, 9, 10 AND 18 CRUSHERS

No. 10 McCULLY CRUSHER.
50-75 HP. single drum 25 Cy. Motors.
25-50-100 Kw. Eng. and Turbo Sets, Dir. Cur.
250-300-500 Kw. Turbo and Eng. Sets.
BELT AND STEAM DRIVEN COMPRESSORS, 50-5000 ft.
5-6-12 Ton 24-in. Gauge Gasoline Locomotives.
Belt Driven Compressors, 50-3000 ft.
6-8-10-in. Sand Pump, belt drive.
25-40 HP. double drum Elec. Hoist, 440 V. 60 Cy.
5-10-15 Ton Holt Tractors.
2—290 HP. NEW B. & W. 200 lb. boilers steel casings.
150 HP. 125 lb. H. R. T. Boiler—Buttstrap, Indpls.
9K GATES REGULAR DRIVE, BARGAIN.

Send Us Your Inquiries Centrif. Pumps, Motors, Compressors and Electrical Equipment

ROSS POWER EQUIP. CO.
Indianapolis, Ind.

SEVERAL BELT BARGAINS

98 ft. 24" 4-ply Rubber-Covered Conveyor Belting, slightly used..............$1.50 per foot
100 ft. 30" 8-ply Canvas-Stitched Belting, slightly used..............$1.62 per foot

NATIONAL BELTING AND SALVAGE CO.
268 East Water St., Milwaukee, Wisconsin

One 50-ton, standard gauge Baldwin Mogul; 170 lbs. pressure.

One 56-ton, standard gauge American 10-wheeler; 175 lbs. pressure.

Two 50-ton, standard gauge Brooks 6-wheel switchers; 160 lbs. pressure.

One 42-ton, standard gauge Shay geared locomotive.

One 24-ton, standard gauge Shay geared locomotive.

One 14-ton, 36" gauge American Saddle Tank.

Two 23-ton, brand new 36" gauge Porter 6-wheel switchers; separate tenders.

One Model 14-B Bucyrus Shovel.

The above are only a few items of our stock. Will gladly send you our complete stock lists.

Birmingham Rail & Locomotive Co.
Birmingham, Ala.

FOR RENT AND SALE

13—6-yd. re-built dump cars, std. gauge.
20—12-yd. Westerns, like new, std. gauge.
50—60,000-lb. capacity flat and box cars.
1—Western standard gauge spreader.
1—Osgood 18 revolving shovel, traction wheels, No. 794, ¾-yd. bucket, used 8 mos.
1—Marion 36 combination shovel and drag-line, No. 4725, caterpillar traction, 1½-yd. bucket; used 4 mos.; built March, 1921.
1—Marion 76 steam shovel, No. 3503, std. gauge.
1—Marion 76 steam shovel, No. 3503, std. gauge.

LOCOMOTIVES

2—32-ton Vulcan four-driver saddle-tank, used sixty days; built March, 1921.
1—40-ton 17x24 in. four-wheel switcher.
2—50-ton 18x24 in. six-wheel switchers.
2—NEW 25-ton six-wheel Porters, separate tenders, 36 in. gauge.
2—18, 14, and 10-ton Vulcans, 36 in. gauge.

Locomotive-Cranes, Railway Equipment, Etc.

INDUSTRIAL EQUIPMENT CO.
McCormick Building Chicago, Ill.

New—RAILS—Relaying

All sections on hand for quick shipment. Reasonable prices quoted. Our stock is very complete.

M. K. FRANK
Frick Building Pittsburgh, Pa.

FOR SALE

D. D. Flory Electric Hoist, drums parallel 48"x36", 82 h.p., 440 volt, 60 cy., 3 ph.
⅝ yd. Bucyrus Shovel, Std. Gauge, Railroad type.
800 ft. Laidlaw Compressor, two stage with intercooler and unloader. Belt drive, with or without motor.

Hulbert A. Bond, Rowayton, Conn.

FOR SALE

2—Model 28 Marion full revolving Shovels on traction wheels, ⅝ yard dippers, shop numbers 3134 and 3137.

H. R. HAMILTON
Union Arcade Pittsburgh, Pa.

Machinery For Sale

DRYERS—Direct-heat rotary dryers, 3x25', 3½x25', 4x30', 5½x50' 6x50' and 7x60'; double shell dryers, 4x20', 5x30' and 6x35'; steam-heated air rotary dryers, 4x30' and 6x30'.

KILNS—Rotary kilns, 3½x25', 5x60' and 6x70', 6x100', 7x80' and 8x110'.

MILLS—6x8', 6x5', 2½x3" 3x3½' pebble and ball mills; 8x4', 6x4' and 4x4' continuous ball mills; 3' March mill; 42", 33" and 24" Fuller-Lehigh mills; 4½x20', 5x11', 5x20', 5½x22' and 6x20' tube mills; 7½x13", 9x15", 16x10" and 30x60" jaw crushers; one "Infant" No. 00, No. 0, No. 2, No. 3, and No. 9 Williams' swing hammer mills; one Kent type "G" mill; 36" and 40" cage mills; 3' and 4½' Hardinge mills; 18x12", 20x12" and 30x10" roll crushers; No. 0, No. 1 and No. 3 Sturtevant rotary crushers; one No. 2 Sturtevant ring roll crusher; 3 roll and No. 000, No. 00 and No. 0 Raymond mills; one No. 5 Telsmith breaker; one 36" Sturtevant emery mill; one 3 roll Griffin mill; 60" chaser mill.

SPECIALS—Five automatic package weighing machines; jigs; one keystone excavator; 6x8', 6x5' and 4x3' Newaygo vibrating screens, Richardson automatic scales.

Air compressors and tanks.

W. P. Heineken, Engineer
[illegible] Liberty Street, New York. Tel. Cortland 1841

Large Crushers

JAW: 24x36-in. Farrel type 15B. 10x36-in. type 22B. Virginia delivery.

Gyratory: Two No. 6 Chalmers & Williams. New Jersey delivery.

All good condition. Do you want details on these or other sizes? Relaying rails in stock.

E. H. Wilson & Company
Commercial Trust Building
PHILADELPHIA

WANTED

Good used Emerick Air Separator. Three or Four Roll Raymond Mill.

Address Box 1500 Care Rock Products
542 S. Dearborn St., Chicago, Ill.

WANTED

A small crusher suitable for crushing brick.

NORTH INDIANA BRICK CO.
Michigan City, Ind.

Take advantage of the Opportunity offered in the Used Equipment Department to dispose of the equipment that you no longer need.

Classified Advertising

Rates for advertising in the Classified Department: $2.50 per column inch per insertion. Minimum charge, $2.50. Please send check with your order. These ads must be paid in advance of insertion.

Plants for Sale

For Sale, Rent or Lease

On a royalty, a modern, equipped, ground, limestone crushing and pulverizing plant with 30 acres of a 30 ft. ledge of the highest testing blue limestone in Southern Ohio. No lack of business. A good local trade; plant now in operation, but am unable to manage it on account of my age and health. A fine location for a larger plant with no chance for opposition. Call on or address at once

FRANK SHARP
Lynchburg, Ohio

Plants for Sale

FOR SALE

Established and successful crushed stone plant and business in Virginia. Now in operation with plenty of orders for balance of season. Two crushers with good output and making good money. Price $25,000; part terms can be arranged. Good reason for selling. Address owner,

Box 1501 Care Rock Products
542 S. Dearborn St., Chicago, Ill.

Opportunity in Barre Granite Quarry

Great deposit granite in central West. Takes beautiful permanent polish. More than equal to Barre. Immense supply. No hoisting or disposal of waste. No heavy machinery required. Close rail. Non-competitive market Mississippi to Pacific. Wanted: Men with sufficient capital to equip and operate wholesale rough dimension quarry; or mutual associated practical granite quarry tradesmen. Big opportunity. Make big money quick. Write O. M. Holmes, Strand Block, Livingston, Montana, for full particulars.

Help Wanted

WANTED

Superintendent for small Lime Plant. Must be experienced and give references.

Address Box 1499 Care Rock Products
542 S. Dearborn St., Chicago, Ill.

Idle Machinery Absorbs Profits

This department is the medium for the men who keep the wheels going. Sell your idle machinery to the man who'll keep it going.

Have you a plant for sale? Do you wish to purchase a plant? Are you in need of a superintendent or manager? Are you looking for a position as plant superintendent or manager? Advertise your wants in these columns for quick results.

Buyers' Bulletin

MANUFACTURERS OF MACHINERY AND EQUIPMENT:—These inquiries are live, up-to-date inquiries that have come direct to us from the individual in each case.

READERS OF "ROCK PRODUCTS":—This Department is for your special help and service. If you do not see what you require advertised in "Rock Products," tell us your needs and we will publish them here. There is no charge for this service.

Harry A. Brooks, 112 Ryerson Ave., Paterson, N. J., desires catalogs on shovels, all makes.

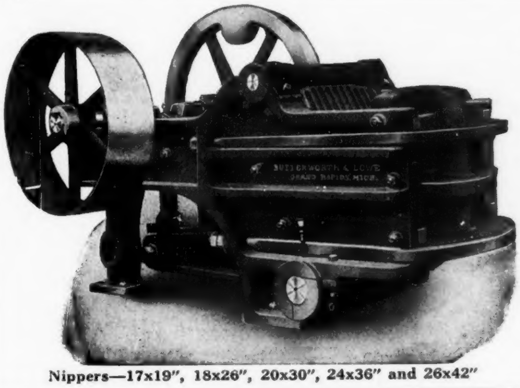
Smith & Petersen, 729 W. 5th St., Reno, Nev., advise that they desire prices and data on machinery for crushing and screening for a sand and gravel plant complete, bank run, no washing required, of 100 yds. capacity per day. Desire information immediately.

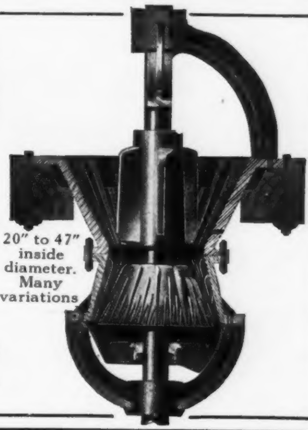
E. P. Crawford, Mining Engineer, Silver City, N. M., advises as follows: "I am making a preliminary investigation for the installation of a small cement plant and desire to come into touch with sources of information for methods, costs, etc.

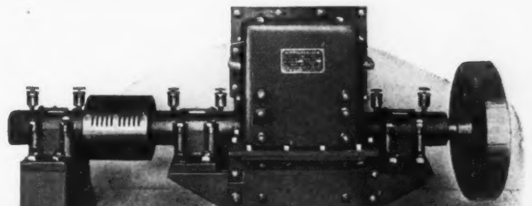
R. J. Schirm, P. O. Box No. 4, Los Angeles, Calif. (American Sand & Gravel Co.), desires catalogs and prices on dragline conveyors, small locomotives and 36″ track, elevators, crushers for sand, rock and gravel plants.

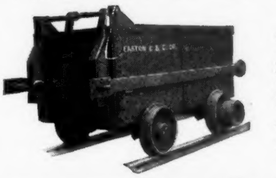
Mr. C. O. Fitts, Care the Belmond Savings Bank, Belwood, Iowa, advises that he is organizing a gravel and sand company to produce these materials on a commercial basis and desires catalogs and data regarding machinery to be used in such a plant.

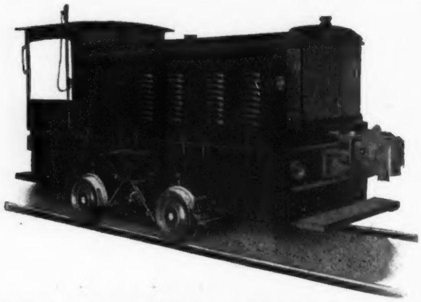
Albany Concrete Stone Co., Albany, N. Y., advise: "We are in the market for an inexpensive truck loader for loading 2″ crushed stone from storage pile to our dump trucks. Would prefer a used machine or some other device to load our automobile trucks, as we store considerable stone in a vacant lot during the fall and we understand a loader will save us money."











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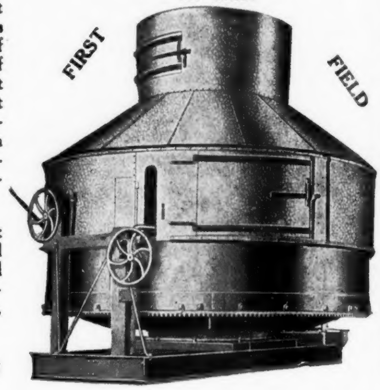

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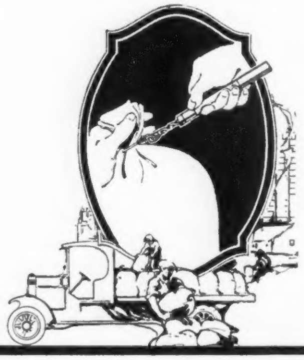

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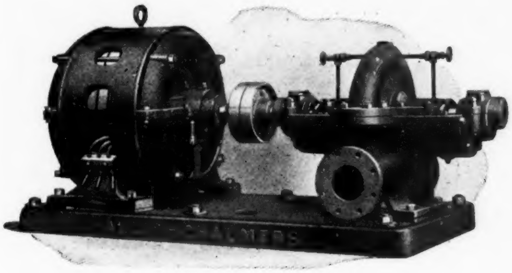

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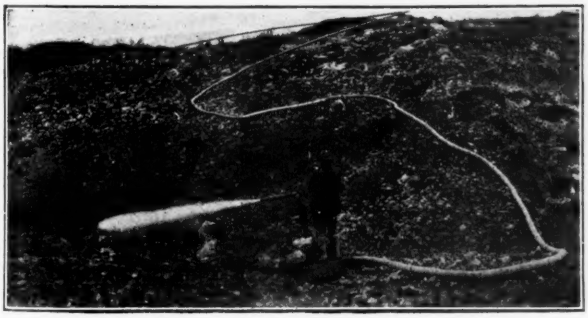

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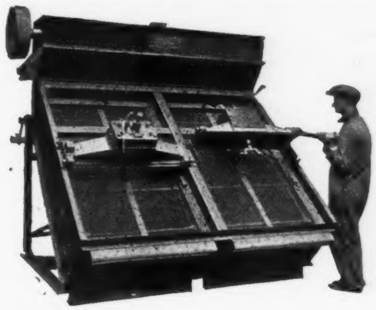

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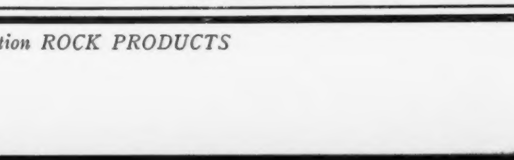

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